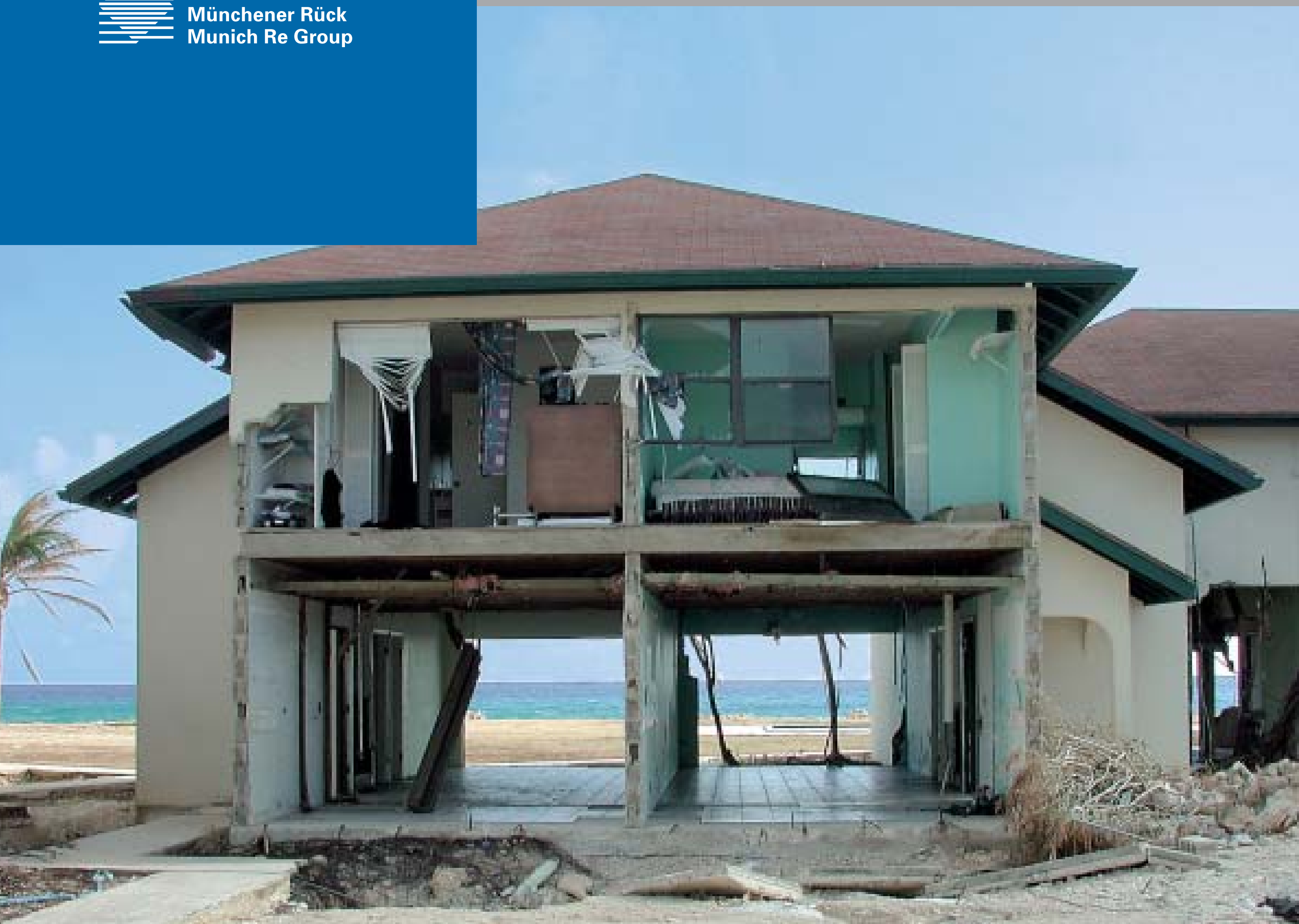
Knowledge series

Topics Geo
Annual review: Natural catastrophes 2004

Natural catastrophes in 2004
Great natural catastrophes since 1950
Tsunami catastrophe in South Asia
Hurricanes in the Atlantic
Typhoon season in the Pacific
Climate summit in Buenos Aires

Münchener Rück
Munich Re Group



Contents

Cover:
Hurricanes Charley, Frances, Ivan, and Jeanne roared across the Caribbean in short succession and then hit Florida. Insured losses came to US$ 30bn, making this hurricane season the most expensive of all time for the insurance industry.

Left:
The third largest earthquake of the last one hundred years occurred in the Indian Ocean on 26 December 2004. It triggered a huge tsunami which devastated the coastlines of Sumatra, Thailand, South India, Sri Lanka, and the Maldives. 170,000 people were killed, more than 100,000 are missing.

Natural catastrophes in 2004 Review – Outlook

Shortly before the end of the year, South Asia was hit by one of the most devastating natural catastrophes of recent decades. An earthquake off the west coast of Sumatra in the Indian Ocean triggered a tsunami (a series of seismic sea waves) which was so strong that it caused devastation on sections of coast thousands of kilometres away.

This human tragedy with more than 170,000 fatalities shocked the entire world, causing deep dismay and helpless grief. In a very dramatic way it demonstrated the power and unpredictability of nature and underlined the urgent need for global prevention measures.

By and large, however, 2004 was dominated by extreme atmospheric events and weather-related natural catastrophes, both in terms of the number of events and the monetary losses they generated. The past year thus confirmed the fear that has long been expressed by Munich Re: global warming – very probably triggered by human activity – is leading not only to an increase in the frequency and intensity of exceptional weather events but also to new kinds of weather risks and greater loss potentials:

- A hurricane formed off the Brazilian coast **for the first time** since observations began – this area had been considered hurricane-free.
- Hurricane Alex intensified to a Category 3 storm on the Saffir-Simpson Scale in the region of 40°N – **unusually** far from the Tropics. Tropical cyclones usually weaken or subside completely in these northern latitudes.
- Florida was hit by four hurricanes in the space of a few weeks – making it the **costliest** hurricane season ever for insurers.
- Japan was hit by ten tropical cyclones – a **record number** that was unequalled throughout the previous century.

Loss figures

Many more than 180,000 people were killed throughout the world as a result of natural catastrophes in 2004. A figure exceeding 170,000 is being quoted as the number of victims of the tsunami catastrophe in South Asia, with fears that it will rise to over 250,000. Around 650 natural hazard events were analysed and documented in 2004, which is in line with the average of the past ten years. Economic losses rose to US$ 145bn (2003: US$ 60bn). The destructive hurricanes in the Caribbean and the United States and the Niigata earthquake in Japan on 23 October had a major impact.

Insured losses rose to US$ 44bn (previous year: US$ 15bn). 2004 is thus the most expensive natural catastrophe year in insurance history to date.

The gigantic catastrophes of the past year are an emphatic confirmation that the insurance industry must be prepared for new loss dimensions from natural catastrophes.

Earthquakes, tsunamis, volcanic eruptions

Of the 650 events analysed and registered by Munich Re, about 85 were due to geological hazards (75 damaging earthquakes and 10 volcanic eruptions). Economic losses came to about US$ 40bn, insured losses US$ 1.5bn.

- On 23 October 2004, Niigata Prefecture on the main Japanese island of Honshu was rocked by a 6.6 earthquake. The quake released more than a thousand landslides, which pulled down roads, railway tracks, and bridges and resulted in a Shinkansen train derailing. Economic losses – primarily involving infrastructure installations which were not insured – reached a total of almost US$ 30bn, with insured losses amounting to some US$ 500,000.
- A quake with a magnitude of 9.0 on the Richter Scale – the third strongest in the last one hundred years – occurred on 26 December in the Indian Ocean off the west coast of Sumatra. The earth's crust shifted by as much as 20 m over a length of approx. 1,000 km and triggered a tsunami, which caused devastation on the sometimes densely populated coastlines of Sumatra, Thailand, South India, Sri Lanka, and the Maldives. Somalia, Kenya, and Tanzania in East Africa were also hit (cf. our documentation beginning on page 26).

Windstorms

Windstorms accounted for almost half of the 650 registered events and 96% of insured losses, thus clearly dominating the natural catastrophe figures in the insurance sector worldwide. Tropical cyclones in the Atlantic and the West Pacific were particularly devastating.

– Record losses were generated by Hurricanes Charley, Frances, Ivan, and Jeanne, which, within the space of only a few weeks, sped across the Caribbean in close succession and then made landfall in Florida. The overall economic loss amounted to over US$ 60bn. Of this sum, about US$ 30bn is carried by the insurance industry, making this hurricane season the costliest of all time. Ivan was one of the strongest and most destructive hurricanes since meteorological recordings began. After devastating Grenada and the Cayman Islands, it moved on to cause severe damage to the oil rigs in the Gulf of Mexico. Finally, it hit Florida with wind speeds of 220 km/h. The result was US$ 11bn in insured losses. Hurricane Jeanne caused record rainfalls especially in Haiti and the Dominican Republic; 2,000 people were killed in the resulting floods and torrents of mud.
– Japan was hit by ten tropical cyclones between June and October. Typhoons Chaba, Songda, and Tokage alone were responsible for economic losses exceeding a total of US$ 14bn, of which approx. US$ 7bn is being carried by the insurance industry.
– On the last few days of November, when the typhoon season was nearing its close, Tropical Storm Winnie unleashed torrential rain over the Philippines. More than 750 people were killed in the flood waters and landslides.
– Europe was fortunately spared extreme winter storms and thunderstorms. However, a few smallish tornadoes caused a stir in Germany, France, Italy, and the United Kingdom, but they caused little damage.
– Tornadoes regularly cause major losses in the United States, and 2004 was no exception. In May, a squall line passed over the US Midwest bringing severe hailstorms and some 85 tornadoes, which generated more than US$ 800m in insured losses and over US$ 1bn in economic losses.

Floods

Floods and flash floods accounted for almost a quarter (150) of all natural hazard events in 2004.

– From January to mid-February, Brazil experienced its worst flood catastrophe of the past 15 years. Heavy rain led to massive flooding in the north and east of the country, which destroyed important infrastructure installations and claimed the lives of more than 160 people.
– In May, record rainfalls in Haiti and the Dominican Republic caused large-scale devastation. 2,000 people lost their lives in the appalling flood waters and mudflows.
– Bangladesh, India, and Nepal experienced extreme monsoon floods from June to August. There was widespread flooding, and in Bangladesh two-thirds of the country was under water for some of the time. More than 2,200 people were drowned in the flood waters, and millions were made homeless. Economic losses are estimated to exceed US$ 5bn.
– Major rivers in China flooded their banks from June to September after heavy rain. Hundreds of thousands of buildings were destroyed, 1,000 people drowned, and economic losses totalled almost US$ 8bn.

Thirty years of geo risks research at Munich Re

For 30 years now, Dr. Gerhard Berz and the Geo Risks Research team at Munich Re have been analysing and documenting natural hazards and the effects of climate change throughout the world. In so doing, they create the scientific basis required by the company's underwriters and Munich Re's clients. What has happened in these 30 years of catastrophe research, what conclusions can be drawn, and what challenges must we expect in the future? Is it possible to quantify the costs that will confront us as a result of climate change? Gerhard Berz, who went into retirement on 1 January 2005 after leading the Geo Risks Research Department for 30 years, has written his own personal view (cf. page 16 ff.). His successor, Professor Peter Höppe, emphasises, "In the coming years there will almost certainly be considerable changes in the way we assess and insure natural hazards; we will have to react to these changes with new approaches and innovative solutions." With his broad knowledge of climate change and its impact on humans, biometeorologist Höppe will further widen the spectrum of the Geo team's work.

Outlook

2004 was the fourth warmest year since temperature recordings began (following 1998, 2002, and 2003). Apart from 1996, nine of the last ten years are to be found in the list of the ten warmest years since 1861. Global climate change is a reality – on that there is a broad consensus among scientists. We all remember 2003 as an exceptionally hot summer in Europe, but it will not remain an exception. On the contrary, extreme weather events may become the norm. The conclusions that scientists have drawn from the hot summer of 2003 are presented and discussed in a special article beginning on page 53.

Although the negotiations at the 10th world climate summit, which took place in Buenos Aires in December 2004, were sluggish, the Kyoto Protocol become binding under international law. Another success was that India and China came out in favour of making more use of renewable energies. Climate protection is making progress, even if only one step at a time.

Angelika Wirtz

With losses of US$ 44bn, 2004 was the most expensive natural catastrophe year ever for the insurance industry. Weather-related natural catastrophes – above all windstorms – accounted for 97% of insured losses. This confirms the assumption we have been expressing for a long time that climate change will lead to an increase in the frequency and intensity of exceptional weather events. This photo was taken in Playa Cana in the west of Cuba. Hurricane Ivan surged over the island at wind speeds of 250 km/h.

Pictures of the year

24 February 2004
Earthquake, Morocco

In the early hours of 24 February, the towns of Al Hoceima and Ait Kamara in the north of Morocco were shaken by a 6.4-magnitude earthquake. Thousands of buildings, most of which were clay-brick structures, collapsed. Numerous villages in the hinterland were completely destroyed. At least 650 people were killed in this earthquake, the worst to hit North Morocco in decades, and hundreds were injured. The economic loss is put at US$ 400m.

February–April 2004
Floods, New Zealand

Thunderstorms, rainstorms, and extended precipitation produced the severest floods for a hundred years on New Zealand's North Island. The main damage was to infrastructure installations, agricultural buildings, and machinery; the agricultural and livestock sectors were also badly hit. Insurance companies received thousands of claims, resulting in payments totalling US$ 70m; the overall economic loss came to US$ 200m.

27–29 March 2004
Tropical Storm/Hurricane Catarina, Brazil

At the end of March, a Category 1 hurricane on the five-level Saffir-Simpson Scale reached the state of Catarina in southern Brazil. This region was not considered to be exposed to hurricanes because of the low temperatures in the South Atlantic. Although an answer to the question of how this unusual windstorm came about has still to be found, there is no doubt about its impact: 40,000 damaged buildings and enormous agricultural losses.

7–21 September 2004

Hurricane Ivan, Caribbean and United States

On its path across the Caribbean and the southern United States, Hurricane Ivan left dramatic scenes of destruction. 90% of the buildings on Grenada were destroyed, the Cayman Islands recorded damage to buildings and infrastructure amounting to US$ 3bn, in the Gulf of Mexico oil rigs had to stop production and were badly damaged, and in Florida a large percentage of the citrus harvest was wiped out. The result: an economic loss of US$ 23bn and insured losses amounting to US$ 11.5bn. Ivan is thus one of the costliest storms in insurance history.

15–19 September 2004

Hurricane Jeanne, Caribbean and United States

Hurricane Jeanne sped over Haiti and the Dominican Republic at wind speeds of 190 km/h. Torrential rain caused rivers to flood their banks and triggered landslides and mudflows. Entire villages were flattened. The flood waters and torrents of mud claimed the lives of 1,800 people in Haiti alone.

26 December 2004

Tsunami, South Asia and East Africa

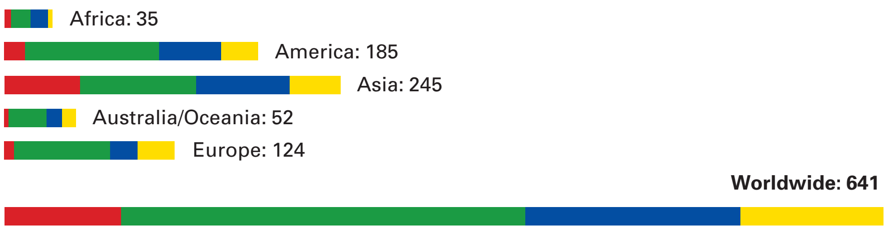
One of the most devastating natural catastrophes of recent decades occurred shortly before the end of the year. A 9.0 earthquake off the west coast of Sumatra in the Indian Ocean triggered a tsunami, whose waves caused devastation on sections of coast thousands of kilometres away. More than 170,000 people lost their lives in the flood waters, more than 100,000 are still missing, tens of thousands were injured, and millions lost everything they had.

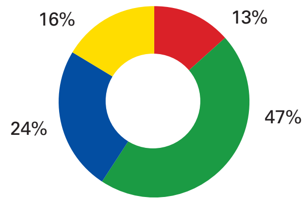
Statistics of natural catastrophes in 2004

Loss events and fatalities

Around 650 natural hazard events were analysed and documented in 2004, which is in line with the average of the past ten years. The year as a whole was dominated by weather-related natural catastrophes, but the most devastating catastrophe in 2004 was caused by an earthquake in the Indian Ocean. It triggered a tsunami, whose waves devastated sections of coast thousands of kilometres away and claimed the lives of more than 170,000 people. More than 100,000 are still missing.

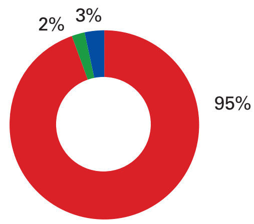
Number of loss events: 641





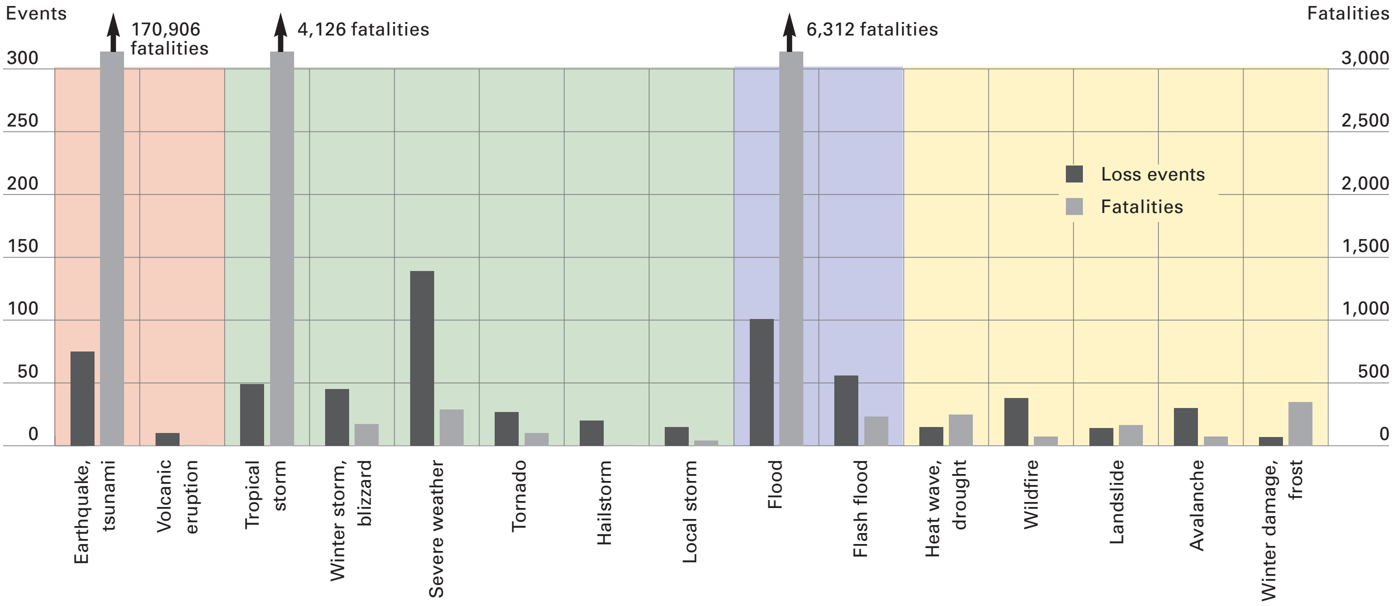
Percentage distribution worldwide

Number of fatalities: 183,000



Percentage distribution worldwide

Breakdown by type of event

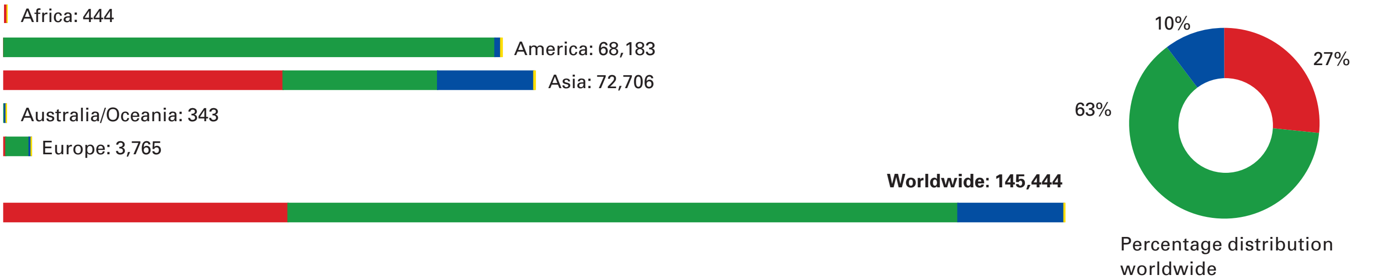


- Earthquake, tsunami, volcanic eruption
- Windstorm
- Flood
- Other events (e.g. wildfires, drought, heatwave, frost)

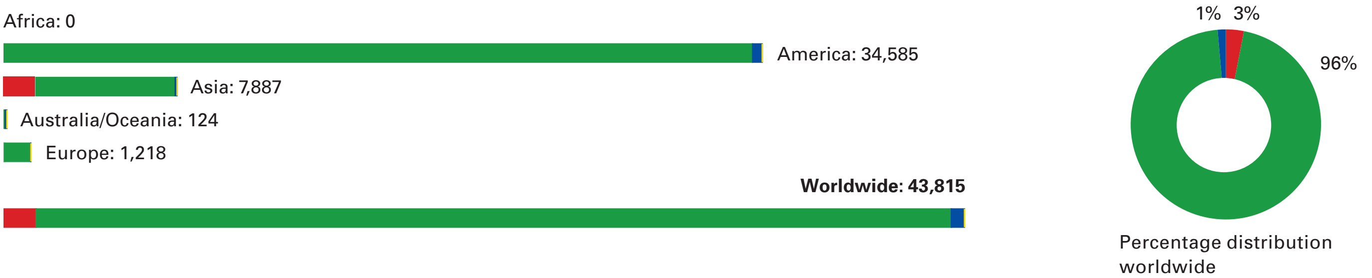
Economic and insured losses

2004 was the costliest natural catastrophe year so far in insurance history. The most expensive losses were those caused by hurricanes in the Caribbean and the United States and typhoons in Japan. The overall economic losses amounted to over US$ 145bn. Almost two-thirds of this total is attributable to windstorms and a third to geological events, in particular the Niigata earthquake in Japan and the earthquake and tsunami catastrophe in South Asia.

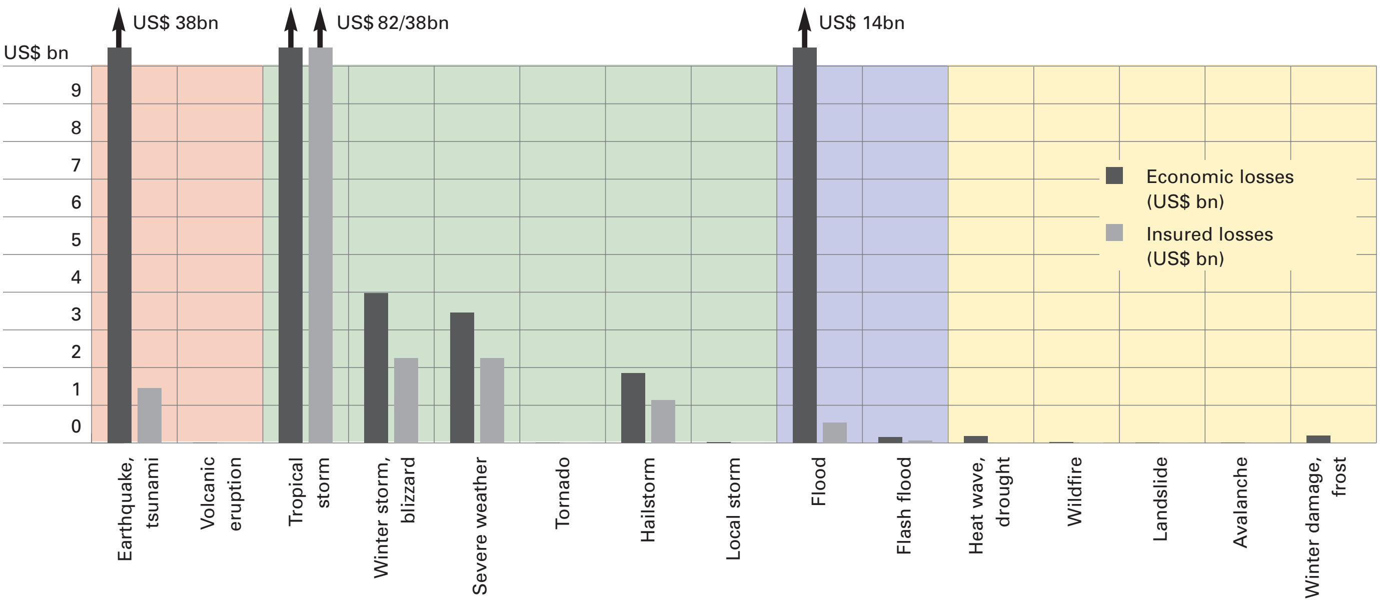
Economic losses: US$ 145bn



Insured losses: US$ 44bn



Breakdown by type of event



Major engineering and fire catastrophes in 2004

There were a large number of engineering catastrophes, explosions, and arson attacks in 2004. Here is a selection of significant events.

19 January, Algeria, Skikda
Explosion in a petrochemical plant

14 February, Russia, Moscow
Roof collapse at an indoor swimming pool

11 March, Spain, Madrid
Bomb attack on commuter trains

22 April, North Korea, Ryongchon
Explosion at a railway station

23 May, France, Paris
Partial collapse of an airport terminal

30 July, Belgium, Ghislenghien
Gas explosion at an industrial park

1 August, Paraguay, Asunción
Fire at a shopping mall

26 August, Germany, Gummersbach
Accident on a motorway bridge

4 November, Denmark, Kolding
Explosion in a fireworks factory

Date	Region	Loss occurrence
19 January	Algeria, Skikda	Explosion in a petrochemical plant An explosion occurred in a gas liquefaction plant at Algeria's largest petrochemical facility, killing 23 workers and injuring dozens. The explosion was probably caused by a defective gas tank. The restoration costs are estimated at US$ 800m.
14 February	Russia, Moscow	Roof collapse at an indoor swimming pool A snow-covered roof collapsed at the heavily frequented Transvaal water park in Moscow. The glass and reinforced concrete structure fell twenty metres and buried 28 people. The accident is attributed to construction defects.
11 March	Spain, Madrid	Bomb attack on commuter trains A total of ten bombs exploded in the middle of the rush hour at three railway stations: Atocha, which is the most important station in the centre of Madrid, Pozo del Tío Raimundo, and Santa Eugenia. It was the worst terrorist attack that Spain had ever experienced, with almost 200 people killed and more than 1,500 injured, some of them severely.
22 April	North Korea, Ryongchon	Explosion at a railway station The outcome of an explosion at Ryongchon station: at least 150 people killed, more than 1,300 injured, and 8,100 homes destroyed. The explosion was triggered by an electrical contact during shunting operations involving wagons loaded with ammonium nitrate, a highly explosive fertiliser.
23 May	France, Paris	Partial collapse of an airport terminal Four passengers waiting for their flights at Paris Roissy-Charles de Gaulle Airport were killed when Terminal 2E collapsed about a year after it had been opened. An even more serious accident was prevented because cracks were discovered in the structure and the affected area was partially evacuated and shored up. The overall loss came to several hundred million US dollars.
30 July	Belgium, Ghislenghien	Gas explosion at an industrial park The worst gas explosion in the country's history occurred at an industrial park 30 km south of Brussels. It was possibly triggered by a leak in a gas pipeline. Three neighbouring factories caught fire too. 20 people were killed, 130 were injured. The insured loss is estimated at more than US$ 100m.
1 August	Paraguay, Asunción	Fire at a shopping mall At least 400 people were killed in a fire at a shopping mall, and hundreds were injured, many of them very severely. The fire broke out in the food court at the supermarket. All the doors of the supermarket were subsequently closed to prevent looting.
26 August	Germany, Gummersbach	Accident on a motorway bridge In a road accident on the motorway bridge over the Wiehl Valley, a car collided with a fully loaded road tanker, which plunged off the bridge and burnt out completely. The driver of the tanker was killed. The bridge was badly damaged by the fire. The loss is in the two-digit million dollar range.
4 November	Denmark, Kolding	Explosion in a fireworks factory 370 buildings were severely damaged or destroyed by explosions and blast waves when a warehouse containing 800 tonnes of fireworks exploded. The fire probably began whilst the fireworks were being loaded onto a lorry.

Intense monsoon rains caused widespread flooding in Bangladesh, India, and Nepal between June and August. 2,200 people were killed in the flood waters and torrents of mud. More than two million buildings were destroyed; industry and small businesses suffered major losses, as did the agricultural and livestock sectors. Economic losses are estimated to be US$ 5bn.

Great natural catastrophes 1950–2004

The year 2004 followed the long-term trend of increasing natural catastrophe losses which Geo Risks Research has been forecasting since the beginning of the 1990s. The year's great catastrophes are powerful confirmation that the insurance industry must be prepared for new loss dimensions.

Hundreds of natural hazard events occur around the world year in, year out. With 650 loss events analysed and documented by Geo Risks Research during the year, 2004 was in line with the average of the last ten years, but in terms of the monetary and human effects, it was a year of exceptional and dramatic events. The most striking examples were the tsunami catastrophe in South Asia, which claimed over 170,000 lives, and the destructive hurricanes that caused enormous property losses in the Caribbean and the United States.

Definition
of great natural catastrophes

In line with definitions used by the United Nations, natural catastrophes are considered "great" if the affected regions' ability to help themselves is clearly overstretched and supraregional or international assistance is required. As a rule, this is the case when there are thousands of fatalities, when hundreds of thousands of people are made homeless, or when economic losses – depending on the economic circumstances of the country concerned – and/or insured losses reach exceptional orders of magnitude.

Nine natural hazard events complied with the definition of "great natural catastrophes":

- Floods, Haiti and Dominican Republic (May)
- Floods, Bangladesh, India, and Nepal (June–August)
- Hurricane Charley, Caribbean and United States (August)
- Hurricane Frances, Caribbean and United States (September)
- Typhoon Songda, Japan (September)
- Hurricane Ivan, Caribbean and United States (September)
- Hurricane Jeanne, Caribbean and United States (September)
- Earthquake, Niigata, Japan (October)
- Earthquake and tsunami, South Asia and east coast of Africa (December)

Comparison of decades 1950–2004

The tables allow a comparison of the aggregate loss figures of recent decades. Comparing the last ten years with the 1960s makes the increase in natural catastrophes particularly clear. This applies both to the number of events and to the extent of the losses incurred.

Decade	**1950–1959**	**1960–1969**	**1970–1979**	**1980–1989**	**1990–1999**	**Last 10 years**
Number of events	20	27	47	63	91	63
Economic losses	44.9	80.5	147.6	228.0	703.6	566.8
Insured losses	**–**	**6.5**	**13.7**	**28.8**	**132.2**	**101.7**

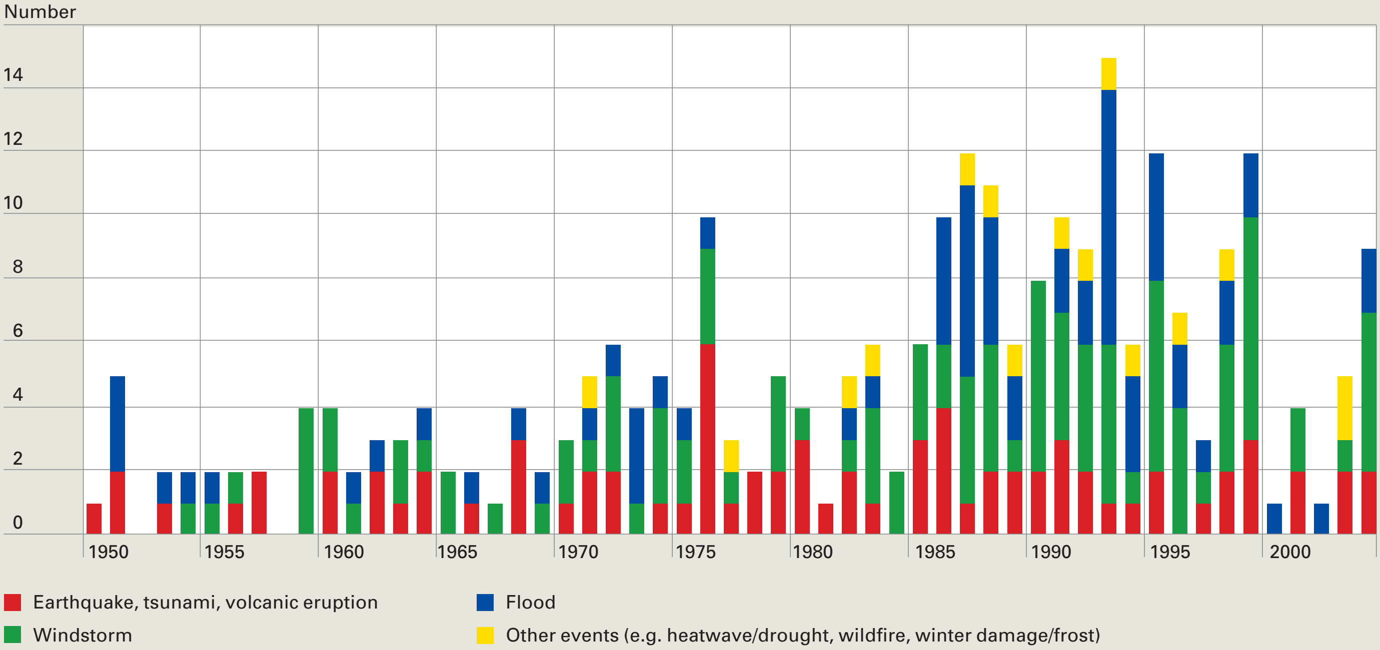
A comparison of the last ten years with the 1960s reveals a dramatic increase.

Last 10:60s
2.3
7.0
15.6

Losses in US$ bn (2004 values)

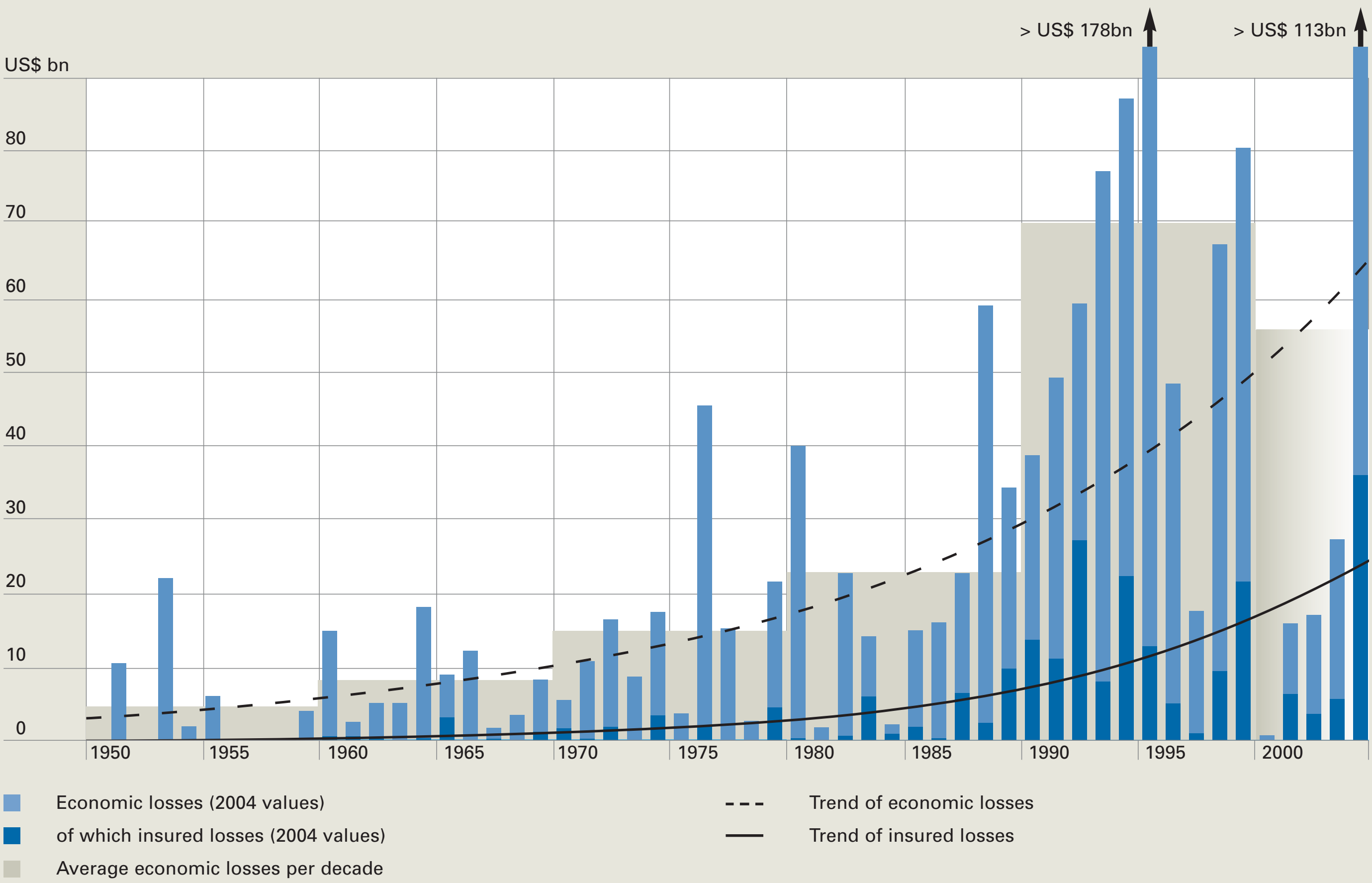
Number of events

The chart shows for each year the number of great natural catastrophes, divided up by type of event.



Economic losses and insured losses – Absolute values and long-term trends

The chart presents the economic losses and insured losses, adjusted to present values. The trend curves verify the increase in catastrophe losses since 1950.



Thirty years of geo risks research at Munich Re

Assessing and reinsuring the risks of today and tomorrow is our business. However, the losses specifically generated by major catastrophes are becoming increasingly unpredictable. That is a challenge for which Munich Re is well-equipped thanks to its long years of experience with natural hazards.

It was June 1974 when geo risks research was launched at Munich Re and the company engaged its first geoscientist to handle the scientific processing of this topic area. Nonetheless, for many years and decades before that, the company's underwriters, actuaries, and engineers had been concerned with assessing natural hazard risks throughout the world. This called for intensive cooperation with a network of experts who were familiar with the latest knowledge in all the respective areas of research: for the history of the reinsurance sector had been marked by natural catastrophe risks from the very outset. This applied in particular to Munich Re: as early as 1906, the earthquake in San Francisco presented the company with an enormous loss of 12 million gold marks. In terms of premium volume, this remains even today the greatest natural catastrophe loss in the history of Munich Re. Its founder, Carl Thieme, took advantage of this critical situation to promote trust in Munich Re ("Thieme is money") and to fuel its breakthrough in the international market.

After a long period of relative calm, natural hazards struck again in the 1950s and 1960s with a series of major blows: floods in Holland (1953), earthquake in Agadir (1960), storm surge in Hamburg (1962), and Hurricane Betsy (1965). At the same time, in the wake of emerging globalisation, the international reinsurance market went through a phase of rapid development, coupled with a dramatic increase in insured losses from natural catastrophes.

The unexpectedly high losses suffered by many insurers and reinsurers after the earthquake in Managua (Nicaragua) in 1972 and Cyclone Tracy in Darwin (Australia) in 1974 came as a real shock.

But not at Munich Re. It had long recognised the writing on the wall and had begun issuing urgent warnings to its clients about the emerging trend with a series of special publications on the subjects of flooding, earthquake, and storm damage. The positive response to this educational campaign strengthened the Board of Management in its decision to commission its first geoscientist to address these topics with the support of two other staff members. This little group had hardly commenced its work when it was confronted with a veritable flood of catastrophes: for example, Hurricane Fifi in Honduras, hailstorms in Bavaria, the Capella gale, earthquakes in Guatemala, Italy, China, and the Philippines – and all were dealt with in numerous publications and loss analyses.

The demand from within the company and from clients for scientific advisory services increased so much that a second geoscientist was hired in the spring of 1977. Not long after that, Munich Re published the first edition of its World Map of Natural Hazards, which has since become one of its unique trademarks. It was very well received and gained recognition all over the world – succeeding, as it did, in presenting a global view of the most important hazard criteria in a straightforward fashion on the basis of a zoning system developed within the company. It is now built on a geographical information system which has allowed it to be re-engineered into an interactive tool (a CD-ROM called "World of Natural Hazards") and enhanced with a wealth of further information. A total distribution of more than 50,000 copies makes this CD-ROM the most successful product in Munich Re's range of geoscientific services, which also includes the attractive Globe of Natural Hazards, the millennium review of natural catastrophes, and a host of other publications – including the most recently published "Storm warning", "Weather catastrophes and climate change", "Renewable energies", and "Megacities – Megarisks".

From the end of the 1980s, there was a gradual influx of additional capacity in the form of geophysicists, geographers, hydrologists, meteorologists, geologists, environmental scientists, and technical staff. The number of staff has now reached 25. It was essential to expand, not least because of the explosive growth in the number and severity of natural catastrophes: at the same time, the need for technical advice within the insurance industry increased, as did the frequency of on-site inspections of catastrophe losses by geoscientists, engineers, and insurance specialists.

There were many different reasons for the escalation in catastrophes, and the following questions came increasingly to the fore.

Is mankind changing the environment and the climate? How intense are the changes in weather extremes? What effects can and will they have on the insurance industry? These are questions that Munich Re has been concerned with since the early 1970s. During that period, western and central Europe were hit by a series of severe windstorms at increasingly short intervals, which gave rise to the conjecture and concern that it was not a matter of chance but an indication that the climate was changing. With the signs of global warming intensifying in the 1980s, climate models revealed plausible physical grounds for the observed trends. Munich Re's geoscientists were the first in their field to substantiate the conspicuous increase in losses from major natural catastrophes, which were largely triggered by extreme weather events. The analysis of the causes identified socioeconomic changes as the main cause of this increase, e.g. the settlement of high-risk areas as a result of rapid population growth or a higher concentration of values.

Nevertheless, one thing was clear even at that time: the influence of what is primarily man-made climate change should on no account be ignored. Particularly with a view to the future, global warming must be considered a critical factor which intensifies the exposure of the world's population, economy, and natural environment to natural catastrophes.

If we maintain a passive attitude towards these changes instead of vigorously fighting their causes, the frequency and severity of natural catastrophes will continue to increase. In ten years, we can expect an average of more than 800 catastrophes every year, almost 90% of which will be weather-related. Economic losses will be distinctly higher than US$ 150bn a year (in today's values), with the insured share rising to about a quarter of that sum, i.e. to approx. US$ 40–50bn. There may be some individual worst-case catastrophes with even higher loss amounts.

Consequently, Munich Re has long advocated sustainable environmental and climate protection and, together with its partners in the insurance and financial sectors, has actively championed both causes. Through its voluntary commitment within the framework of the United Nations Environmental Programme (UNEP), Munich Re is making its own contribution by, for instance, reducing the impact of its own operations on the environment and supporting numerous climate protection projects. Above all, however, it takes sustainability aspects into account both in its reinsurance business and in its investments and has established itself in this respect as a driving force in the financial sector.

In spite of all the concerns with regard to future developments, Munich Re's global vision and its expert knowledge ensure that it is well-equipped to deal with the challenges of the future. All the same, the future will also depend upon whether man is governed by reason and responsibility and prevents nature from getting out of control. We see our task as reinsurers not only in identifying risks and developing insurance solutions but also in making our knowledge and potential prevention measures available to the public at large.

Dr. Gerhard Berz

Weather catastrophes 1974–2004

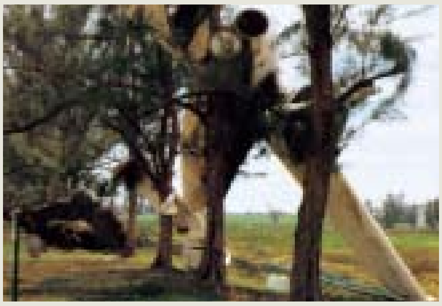
1974
Hurricane Fifi, Honduras

1974
Cyclone Tracy, Australia

1976
Winter Storm Capella, Europe

1984
Hailstorm, Munich, Germany

1987
Winter storm 87J, Western Europe



1988
Hurricane Gilbert, Caribbean, Central America, USA

1989
Hurricane Hugo, Caribbean

1990
Winter storms, Europe

1991
Oakland fire, California, USA

1991
Flash flood, Bangladesh

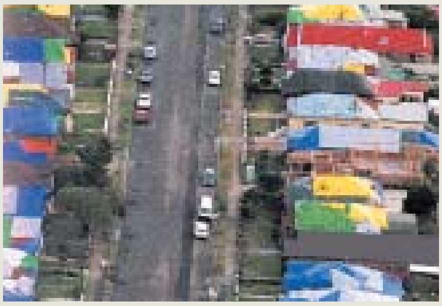
1992
Hurricane Andrew, Florida, USA

1993
Flood, Mississippi, USA

1995
Flood, Cologne, Germany

1998
Hurricane Mitch, Central America

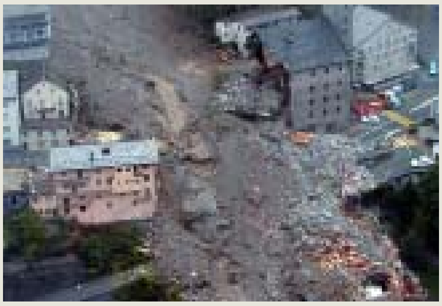
1998
Blizzard, Canada and USA



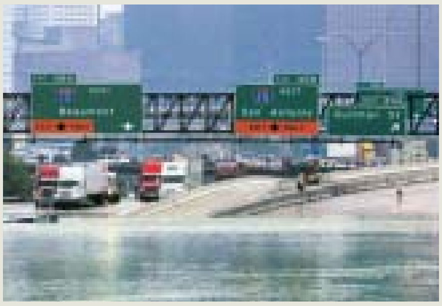
1999
Hailstorm, Sydney, Australia

1999
Winter Storm Lothar, Europe

2000
Flood, Mozambique



2001
Landslides, Italy and Switzerland



2001
Tropical Storm Allison, Houston, USA

2002
Floods, Europe

2002
Tornadoes, USA

2003
Heatwave, Europe

2004
Hurricane Ivan, Caribbean, USA

The tsunami catastrophe of 26 December 2004 demonstrated in a very dramatic way the power and unpredictability of nature and underlined the urgent need for prevention measures.

Earthquake report:

The Niigata earthquake in Japan

On 23 October 2004, the earth trembled in Niigata Prefecture. Although the region is relatively sparsely populated, the quake generated economic losses of US$ 30bn, making it one of the costliest natural catastrophes worldwide. The event highlights the enormous loss potentials in highly developed industrial countries.

Scientific aspects, features of the quake

The 6.6 Mw earthquake occurred at 5.56 p.m. local time. The hypocentre was at a depth of approx. 13 km near the town of Ojiya, some 70 km from Niigata with its population of over 500,000.

Neither the strength of the quake nor its location are surprising. Japan is located at a point where three large tectonic plates meet: the Philippine, Eurasian, and Pacific Plates. Their movements result in large subduction quakes off the coast of Japan and strike slip and thrust faults throughout the country. In the past too, a number of medium to strong tremors had been registered in the region. The last time was in 1964, when Greater Niigata was shaken by a severe quake which caused major devastation in the city and cost the lives of 30 people. The earthquake in 2004 was on a thrust fault in the central part of Niigata Prefecture. On the seismic hazard map of Japan, this region is allocated to Intensity Zone 3, corresponding to an expected earthquake intensity of at least VIII within a period of just under 500 years.

One feature of the event was the extremely high ground acceleration. At approx. 1.7 g (g = acceleration of gravity) the ground acceleration was twice as high as that in the Kobe quake of 1995 – making it one of the highest ever recorded. Fortunately, the area affected by high ground acceleration was very limited. The earthquake was followed by an exceptionally large number of strong aftershocks, some of which had a magnitude of Mw > 6 and made the situation in the region even worse.

Claims

Forty people were killed in the quake, more than 4,500 were injured, and more than 50,000 were made homeless. There was much damage to property in the towns of Ojiya and Nagaoka. More than 12,500 houses were partially or completely destroyed, a further 90,000 were damaged. Fortunately, the area most severely affected has a relatively sparse population and is mainly rural. Nevertheless, economic losses totalled roughly US$ 30bn, primarily because of the widespread destruction of the local infrastructure. Hardly any roads were left intact in the hardest hit area. Innumerable bridges, the motorway, and railway lines were severely damaged, including the line used by the high-speed Shinkansen train. For the first time ever, one of these trains derailed during an earthquake – whilst travelling at its top speed of over 200 km/h. Although the train hurtled on for a further 1.5 km before coming to a halt, this did not end in disaster, and nobody was killed.

But why should there have been such enormous damage to infrastructure in a highly developed country like Japan, which is known as a pioneer in the field of earthquake engineering? The first reason was the extreme ground motion, which far exceeded all the design criteria in the building code. Another was that losses were increased significantly by countless landslides triggered by the earthquake. Following a number of typhoons (in particular Tokage shortly before the quake) the region had experienced extreme precipitation levels in September and October so that the ground was saturated and very unstable. There were hundreds of landslides, burying houses and roads and devastating whole areas. There was intense ground settlement throughout the region, destroying roads, bridge approaches, and river embankments.

Although the losses were unusually high, the Niigata quake was only of marginal interest to international reinsurers compared with the windstorm losses of 2004.

More than 100,000 buildings were damaged or destroyed in the earthquake that hit Niigata Prefecture on 23 October. There were hundreds of landslides, which devastated whole areas.

Earthquake insurance for residential buildings is uncommon in Japan and is subject to strict limits; reinsurance is assumed to a certain degree by the state. Reinsurers would have carried a share of the losses from residential policies only if even more buildings had been affected. Most of the damage to infrastructure, in particular to the Shinkansen line, was not covered by private-sector insurance either. The greatest impact on reinsurers from earthquakes in Japan is to be expected from the commercial and industrial sectors. As there were very few of these risks in the region mainly affected, the reinsurers came off very lightly this time.

Conclusion

The earthquake in Niigata Prefecture caused an exceptionally large economic loss of approx. US$ 30bn and claimed the lives of 40 people. In contrast, one year before, a quake of the same magnitude devastated 70% of the small town of Bam in Iran and killed more than 26,000 people, but there was only a small economic loss of US$ 500m. This comparison is a forceful demonstration of the correlation observed throughout the world between a low level of development coupled with a large number of fatal victims on the one hand and huge loss potentials in highly developed countries on the other.

Modern earthquake-resistant construction methods like those applied in Japan can produce an impressive reduction in the number of fatalities, but they do little to minimise losses. Industrial countries are traversed by dense and complex infrastructural systems and have built up staggering concentrations of values. As we have seen, huge losses may be generated even by a quake in a primarily rural part of Japan with a relatively sparse population.

Top: Economic losses amounted to about US$ 30bn. The local infrastructure in particular suffered large-scale destruction. Hardly any roads were left intact in the hardest hit area.

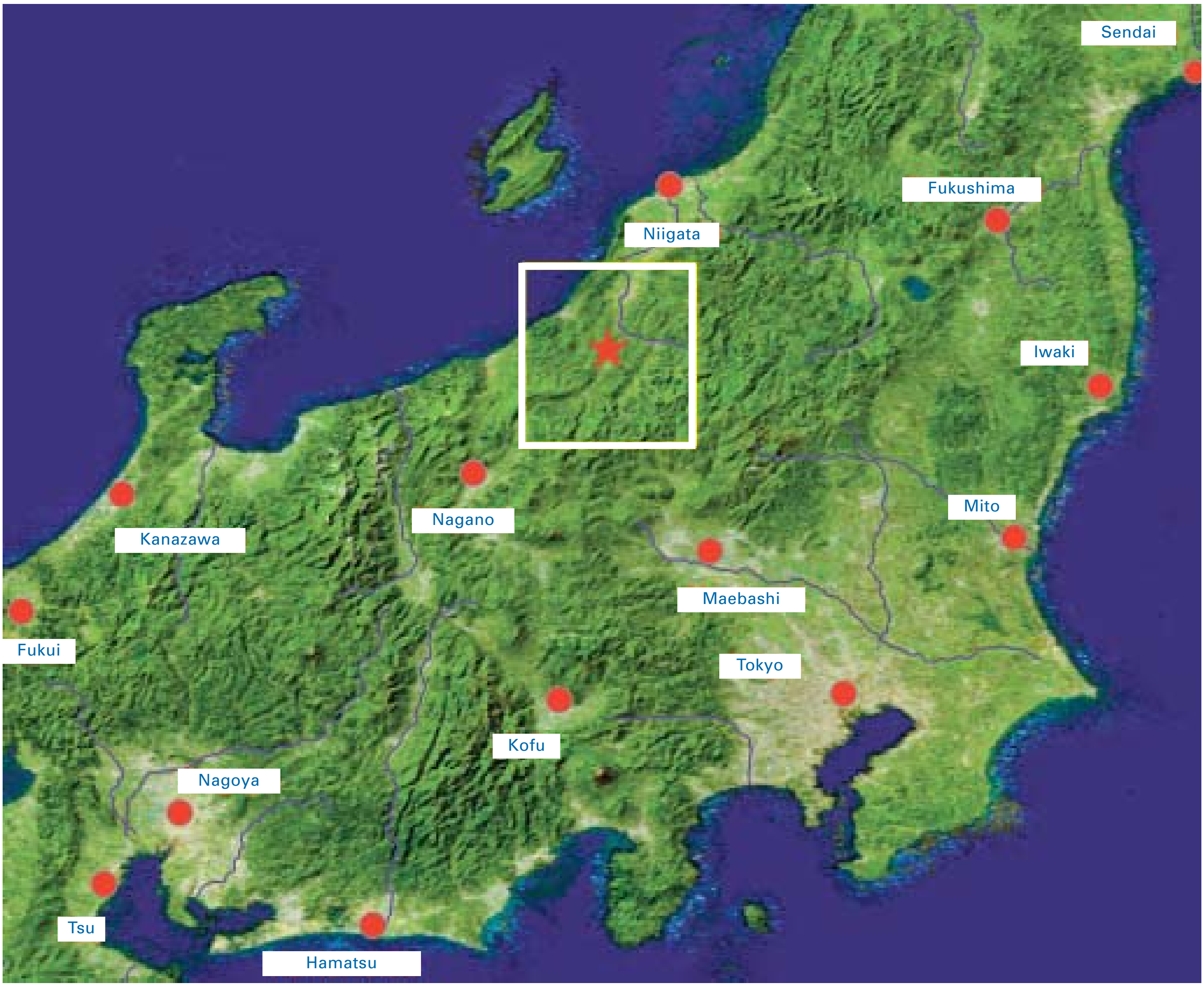
Bottom: This was the first time ever that a Shinkansen train had derailed because of an earthquake. The train hurtled on for a further 1.5 km before coming to a halt. Luckily, this did not end in disaster, and nobody was killed.

The costliest natural catastrophes in history

Ranking by economic losses

Date	Country, region	Event	Fatalities	Economic losses US$ m*	Insured losses US$ m*
17.1.1995	Japan, Kobe	Earthquake	6,430	> 100,000	3,000
17.1.1994	USA, California	Earthquake	61	44,000	15,300
May–Sept 1998	China	Floods	4,159	30,700	1,000
23.10.2004	Japan, Niigata	Earthquake	39	28,000	450
23–27.8.1992	USA	Hurricane Andrew	62	26,500	17,000
May–Aug 1996	China	Floods	3,048	24,000	445
7–21.9.2004	USA. Caribbean	Hurricane Ivan	125	23,000	11,500
May–Aug 1993	USA	Floods	48	21,000	1,270
11–14.8.2004	USA. Caribbean	Hurricane Charley	36	18,000	8,000
12–20.8.2002	Europe	Floods	37	16,000	3,400

*Original losses



Position of the epicentre (star) and the worst affected area. Hardly any damage was registered in Nagano and Niigata.

If densely populated areas are hit by a severe quake, the vulnerability of industrial societies means that a major loss is unavoidable on account of the high values involved, even though the earthquake exposure is known.

Violent earthquakes can be expected to hit industrial countries in the future too, resulting in new record losses. Advances in seismology and earthquake engineering cannot stop this happening, but they do put us in a better position to prepare for such catastrophes with appropriate prevention measures and hence enable us to alleviate their effects. If it is possible to assess the extent of future losses, the insurance industry will be able to adjust to the situation by means of effective risk management. Earthquake insurance will then be a viable proposition in countries like Japan and the United States too as the risks will remain calculable.

Alexander Allmann

Earthquake report:

Tsunami catastrophe in South Asia

The human tragedy caused by the seaquake in the Indian Ocean west of Sumatra at the end of last year has provoked shock and dismay right around the world. The conclusions that politicians, scientists, and insurers will draw from this event are clear: what we need now is prevention, education, and accumulation control.

On the morning of 26 December 2004, an earthquake occurred in the Indian Ocean west of Sumatra, a region where strong earthquakes are nothing out of the ordinary; but this time the shaking was much stronger than expected. It was the largest earthquake in 40 years. However, the fact that made the scale of the quake so astonishing and so difficult to grasp was the gigantic sea wave that followed it, which resulted in the worst human disaster caused by a natural hazard event since the Tangshan earthquake in China in 1976. In terms of the number of fatalities, this tsunami was the largest in documented history.

At the time of writing, mid-February 2005, the UN is talking about at least 170,000 dead, 100,000 missing, and more than 1,000,000 homeless.

The affected area is huge, extending several thousand kilometres – from Thailand and Malaysia in the east via Sri Lanka, India, and the Maldives as far as Kenya and Somalia in the west; even there, 5,000 km from the epicentre, there were almost 300 fatalities. And yet the losses themselves, both human and material, are concentrated on just a narrow strip of coast, one to two kilometres wide, which was exposed to all of the tsunami's extreme destructive force.

The cause of the earthquake

Along the Sunda Arc, the Indo-Australian Plate subducts beneath the Eurasian Plate in a north-northeast direction at a speed of 5–6 cm a year. Earthquakes are common in this subduction zone. Large quakes are not unusual either, the last two being recorded on 4 June 2000 (M = 7.9; 58 fatalities) and on 2 November 2002 (M = 7.4; 30 fatalities). A further quake occurred on 25 July 2004 with a magnitude of 7.3. None of these events received much coverage in the world press. Much stronger quakes are known to have happened in past centuries. They often triggered tsunamis, which – as far as we know – only affected the coasts in the vicinity, with the possible exception of the quake off the coast of Central Sumatra in the year 1833, with a magnitude comparable to that on 26 December 2004. An ocean-wide tsunami has been simulated for this quake too, but due the position of the hypocentre it spread more to the south.

The position of the hypocentre on 26 December 2004 was 3.3 N and 95.8 E at a depth of 10 km, about 250 km south of Banda Aceh, a town on the northern tip of Sumatra. With a magnitude of 9.0, it was the third strongest earthquake to have occurred since the beginning of instrumental records at the end of the 19th century. Its rupture surface was north of the rupture surface of a quake that occurred in 1861 (Fig 1). The rupture propagated from the south over a distance of 1,200–1,300 km. There was an average displacement along the fault of probably 10–15 m, in some places up to 20 m. This resulted in the sea floor shifting vertically by 3–4 m. Whole islands that had been drawn downwards centimetre by centimetre over the decades shot upwards in a matter of seconds.

The tsunami

The vertical displacement of the sea floor over a thousand kilometres triggered a seismic sea wave or tsunami. The rapid upward movement of the ocean floor lifted the overlying water column and produced a wave that spread out to the west and the east. The size of a tsunami depends on the strength of the earthquake, the height of the water column above the epicentre, and the speed and direction of the crust rupture. In this case the tsunami was probably made up of waves approx. 200 km long. The tsunami's three or four high waves were little more than a metre in height on the open sea. Tsunami waves are quite different from all other waves in the ocean. They are much longer and stretch along the entire water column. They travel very fast without losing much energy. The speed they reach depends on the depth of water in the ocean as a whole and can be anything up to 800 km/h. Tsunamis are hardly perceptible on the open sea – and do not pose any danger there either. It is only when they slow down in shallow water that they become dangerous. At this point, they "run up" – i.e. they become shorter and slower – and drop to a speed of 35 km/h at a water depth of 10 m. And their height increases accordingly. Suddenly a wall of water 5 to 10 metres high – and in extreme cases even higher – towers up near the shoreline. One particularly malicious feature of tsunamis is that the sea often recedes before the first wave lands. This unusual phenomenon makes people curious and recurrently claims large numbers of victims.

The propagation area of the tsunami: Affected sections of coast are marked yellow, severely affected sections orange. The cross-hatched areas are – as far as possible – the reconstructed rupture surfaces of the largest quakes (1833, 1861, and 2004). The epicentre of the quake on 26 December 2004 is marked by a yellow star; the red stars represent quakes that have occurred since 1973 with a magnitude of 7.0 and above.

The approximate duration of the tsunami is shown by isochrones constructed at half-hour intervals.

The ultimate impact of a tsunami will depend to a decisive extent on the local topography of the seabed near the shore and of the shoreline itself. If there is a vertical obstacle, the incoming wave will quickly lose most of its gigantic energy and there will not be enough room for a high wave to build up. An atoll with these features will therefore be flooded by a relatively flat, slow wave – as was the case on the Maldives on 26 December 2004. If, on the other hand, the shoreline has an even, moderate gradient, the waves can race up the slope at high speed. The maximum depth of water reached in this way (known as the run-up) is many times greater than the height of the wave itself.

Unlike waves that are generated by storms, the height of the original wave is not the most important factor as far as its destructive power is concerned: this is determined by the flow velocity, the topography of the coast, the direction the tsunami may take, and its path.

A further effect of a tsunami is its refraction at a boundary layer. This is a familiar concept in the field of optics and will become clear in the following example. One of the most severely stricken places on Sri Lanka was Galle, even though it was not directly in the tsunami's path. The pronounced topography of the ocean floor reduced the speed of the tsunami when it arrived at the continental shelf south of Sri Lanka. The part of the sea wave that was south of that point was deflected northwards and hit a section of island where it was completely unexpected. It literally ran around the island. All this happened far from where the tsunami was generated.

As a rule, a substantial proportion of a tsunami's destructive potential is developed near its source. On a long-term average, more than 90% of all human and material losses are incurred near the epicentre – even in the case of large tsunamis. The waves in this area are much higher and much faster. This is confirmed by footage from Meulaboh, a town on Sumatra near the epicentre. The force with which the water poured into the town was incomparably greater than that observed in other regions. In large parts of Sumatra, even trees were unable to withstand the brunt of the surge.

The quake

In spite of all the attention paid to the resulting tsunami (which is likely to have generated at least 95% of the entire loss) the earthquake itself should not be completely ignored, because one of the remarkable aspects of this event was the damage it failed to cause. Given such a strong earthquake, it would have been reasonable to expect at least isolated damage especially to relatively high buildings in more distant metropolises like Kuala Lumpur (500 km) or Singapore (900 km). In fact, however, the tremors there were not as pronounced as in the much weaker quakes of recent years. The task now is to examine very carefully what factors were responsible for this and how the findings can be incorporated in other scenarios, e.g. for the earthquake off the central coast of Sumatra in 1833.

Severity of losses

Economic losses: According to provisional estimates (February 2005), the material losses caused by the catastrophe come to approx. US$ 10bn. The indirect consequential losses are also exceedingly large, particularly in tourist centres in Thailand, Sri Lanka, and the Maldives. In absolute terms, the economic cost is likely to be well below that of the Niigata earthquake in Japan on 23 October 2004 (cf. the report beginning on page 22).

Seldom has a natural catastrophe demonstrated so dramatically just how widely the human effects can diverge from the economic effects, including the impact on the macroeconomies of the affected countries. The Indonesian economy, for example, was hardly affected although more than 100,000 people are expected to have been killed, with a further 100,000 missing. In Thailand, the growth in GDP will possibly be 0.5% lower than anticipated before the quake. The catastrophe only seems to have had a major impact on the economies of the Maldives and Sri Lanka, which are very dependent on tourism. But even in Sri Lanka, the loss is estimated to be no more than 2% of GDP.

Insured losses: A vital lesson to be learnt by insurers from the Sumatra tsunami is that it was a truly global event. Unlike other events, it had an impact not only on local companies and global players but also on national companies in countries far removed from the area that were affected by way of the tourist trade. The global aspect did not manifest itself through international reinsurance as in other catastrophes but through primary insurance. Linked to this is the multi-class aspect. Many classes of business were involved, in a combination not typical of natural hazard events.

At the beginning of 2005, it is impossible to give any complete or accurate statement on the insured losses. Given all the uncertainties at this stage, a loss in the order of US$ 2bn cannot be ruled out. Compared with the human catastrophe and the degree of destruction on the coasts, however, the insured losses appear to be quite low – for the following reasons:

- The worst-hit regions are mostly in developing countries, where even a standard fire cover is by no means the norm. What is more, the earthquake hazard – which usually includes tsunami – is only covered as a supplement to fire insurance.
- Life insurances are not very widespread in these countries either – partly for cultural and psychological reasons, but partly also because of the social status of the majority of the local victims.

IKONOS satellite images of the Banda Aceh region before (left: on 10 January 2003) and after the tsunami (right: on 29 December 2004).

For these reasons, claims are expected to involve two main areas:

- Investments in tourist facilities, especially hotel complexes, and the respective infrastructure. They are often (but not always) covered by an all-risks policy, which may also include business interruption.
- Life, accident, and travel insurance taken out by tourists.

Motor own damage losses can also be expected, although the volume will be negligible. The marine sector was affected in one case because of damage to a car depot that was located in a harbour. Whether there will be many claims to pay under microinsurance programmes is not known at the time of writing. These are covers that were specially designed to safeguard the financial future of private individuals and small firms in developing countries and have already become relatively widespread in India and Indonesia.

Early warning and prevention

Like any other unexpected event, the tsunami catastrophe revealed serious gaps in risk perception and in catastrophe prevention and management. It should not be forgotten, however, that this was a singular event without precedent in any of the affected areas apart from Indonesia – with the possible exception of the earthquake in 1833. Many people in politics, science, and business have called for an early-warning system to be set up for the Indian Ocean like the one that is already in place for the Pacific region. The first steps in this direction were taken at the World Conference on Disaster Reduction held in Kobe in January 2005.

How does Munich Re appraise the situation? It is true that there would have been enough time to warn the people on the coasts of Sri Lanka, India, and Africa and that many of them could have been evacuated if a warning system had been in place. This does not apply to Sumatra, though. Future prevention measures must therefore focus on the elementary level. A large portion of the tragedy could have been prevented if the people, both locals and tourists, had been aware of a few quite simple rules: that an earthquake can result in a tsunami, that a sudden receding of the sea is the sign of an impending tsunami and on no account a curiosity to be gazed at, that the first wave is bound to be followed by a second and a third, and that the only sensible reaction is to escape to higher terrain as quickly as possible.

An early-warning system is only a viable solution if it is supported by instruction and education and if the organisational and communication structures are in place to ensure that once a warning is issued, it has the desired effect (i.e. the early-warning system is part of holistic risk management). One thing that must be taken into account in all these considerations is that an event of these dimensions had not occurred in the Indian Ocean for at least 171 years and may not happen again for many decades or even longer. This makes it extremely difficult to maintain a good level of risk awareness, even in areas that are highly exposed. Although the probability of tsunamis occurring in Indonesia is high, an early-warning system is unlikely to be effective there because of the very short distance between the source of a tsunami and the coastal area it would affect. And on the east coast of India, prevention measures for the cyclones that occur there every year ought to be given higher priority.

Insurance aspects

Like the World Trade Center loss, this earthquake catastrophe shows that accumulation estimates for very rare events cannot be derived from a simple extrapolation of normal events. Losses from earthquakes in areas like the Maldives and the south of Thailand have, for understandable reasons, been omitted from accumulation considerations up to now, not to mention an accumulation of losses in these two countries.

How seriously must tsunami scenarios be taken as accumulation scenarios? The answer to this question is linked to the occurrence probability on which accumulation events are based. However tragic the Sumatra earthquake may have been, it does not represent a relevant accumulation scenario for insurers – given current underwriting practice – because the scale of the insured losses was simply too small. What about other ocean basins? Large tsunamis are possible in the Pacific, the Atlantic, the Caribbean, and the Mediterranean. The tsunami following the great Lisbon earthquake in 1755, which affected the entire west coast of the Iberian Peninsula and parts of the North African coast, is an example of an Atlantic tsunami. In the Mediterranean, the tsunami triggered by an earthquake in 365 AD (with its epicentre probably off the island of Rhodes) reached land all along the eastern Mediterranean coast. The 1960 earthquake in Chile triggered a tsunami which spread throughout the Pacific and claimed 132 lives in far-off Japan. As tsunamis only affect narrow strips of coast, they can only be considered potential accumulation scenarios in the case of gigantic events that would affect numerous extensive sections of coast or regional events that would have a severe impact on a conurbation. A further important consideration is that tsunamis are triggered not only by earthquakes but also by such events as volcanic eruptions (Krakatoa in 1883) or flank collapses. A widely cited scenario of a mega-catastrophe is the collapse of the west flank of the Cumbre Vieja on La Palma – possibly producing a tsunami which could even reach the east coast of the United States while still maintaining a considerable height. The statistical probability that such an event will happen on the Canaries is no more than once in around 100,000 years. Furthermore, it is a matter of conjecture whether the sliding material would plunge into the sea in one single heap or in the form of several smaller landslides with correspondingly smaller tsunamis – although even these would spell danger to coasts in the more immediate vicinity.

Even if the accumulation risk still needs to be examined more closely, the immediate lessons that insurers need to learn from the Sumatra tsunami lie elsewhere.

- Price: If the risk is to be insured, a commensurate price must be charged for the cover, which certainly did not happen in the majority of the regions affected in this case. It is very possible that there will be a few areas where insurance cannot be granted without prevention measures being required because of the particularly high exposure there.
- Contribution to accumulation losses from earthquakes: Although some accumulation scenarios for tsunamis hardly appear justifiable, it is certainly worth examining whether they can cause significant additional losses in earthquake scenarios for coastal areas.
- Cover for tourism risks: In view of the damage to hotels, and the global and sometimes vigorous development of sea coasts into tourist centres, a careful risk assessment is recommended with regard to the tsunami hazard.

The problem of mega-catastrophes (like the Cumbre Vieja scenario) can only be regulated by way of a general exclusion of liability.

The largest tsunami catastrophes since 1700

Date	Tsunami trigger	Earthquake magnitude	Affected regions*	Fatalities**
27.1.1700	Earthquake	9.0	USA*. Japan	
1.11.1755	Earthquake	8.7	Portugal*. Morocco	> 30,000
May–July 1815	Eruption of Tambora		Indonesia	> 10,000 by tsunami
24/25.11.1833	Earthquake	9.2	Indonesia*, Sumatra. India. Sri Lanka	unknown
26/27.8.1883	Eruption of Krakatoa		Indonesia	36,400
15.6.1896	Earthquake	8.5	Japan*, Sanriku	27,000
31.1.1906	Earthquake	8.2	Ecuador*. Colombia	500
27.11.1945	Earthquake	8.3	Pakistan*. India	4,000
1.4.1946	Earthquake	7.5	USA*, Hawaii	150
4.11.1952	Earthquake	8.2	Russia*, Kamchatka	1,300
9.3.1957	Earthquake	8.3	USA*, Hawaii	0
22.5.1960	Earthquake	9.5	Chile*. USA, Hawaii. Japan	3,000
28.3.1964	Earthquake	8.4	USA*, Alaska, Hawaii. Japan. Chile	3,000
26.12.2004	Earthquake	9.0	Indonesia*, Sumatra. Sri Lanka. India. Thailand. Maldives. East Africa	> 170,000

*Epicentre of earthquake

**Fatalities caused by earthquake/volcanic eruption and tsunami, if not otherwise stated.

Conclusion

Although insured losses were comparatively low, an analysis of these losses shows that action needs to be taken on the scientific side, at a political level, and in the insurance industry itself. The focus must be on the following goals:

– Improving awareness of how tsunamis are caused and how the offshore and onshore topography determines the extent to which coasts are exposed
– Improving risk awareness among the people potentially affected and the decision-makers through training and instruction and, if appropriate, through regular disaster drills
– Designing and implementing a global early-warning system
– Setting up communication structures to ensure an efficient response to warnings
– Regulating land use particularly on highly exposed strips of coast
– Reviewing and analysing the coverage practices in all the classes of business involved
– Assessing the accumulation loss potential or the contribution to the accumulation loss from earthquakes
– Giving thought to the calculation of a price that is commensurate with the risk

Dr. Anselm Smolka, Dr. Michael Spranger

The hurricane season in the Atlantic and the typhoon season in the Pacific were exceptional, in terms of both the extent of damage and the meteorological parameters. Four hurricanes in the Caribbean and the United States in August and September 2004 produced a record loss for the insurance industry, whilst Japan was hit by an unprecedented ten tropical windstorms. This hangar in Punta Gorda, Florida, was severely damaged by Hurricane Charley.


66

Watch out! Storms ahead!

Series of cyclones and exceptional windstorm events around the globe

Four hurricanes in the Caribbean and the United States in August and September 2004 led to a record loss for the insurance industry. Japan was hit almost simultaneously by a series of ten tropical cyclones such as had not been observed in the recent past.

Rare events? This was a question we looked at in TOPICS ***geo*** 2003. Last year's analysis related to Hurricane Fabian on Bermuda, Hurricane Juan, which made landfall near Halifax on the east coast of Canada, and Typhoon Maemi in South Korea.

The regions affected by rare and exceptional events in 2004 were regions whose exposure to tropical cyclones was (ostensibly) well-known from historical time series, some of which go back over 150 years. What made 2004 so special was the fact that tropical cyclones had regional frequencies and – in the case of Hurricane Ivan – intensities that were observed for the first time in the time window for which meteorological data are available. To attribute this to the natural variability of windstorm activity is no longer really plausible. Consequently, an issue the insurance industry can no longer disregard is the impact of climate change on extreme weather events and the effect this will have on the risk of change. This includes making a critical examination of hurricane and typhoon risk models with a simulation kernel based on an unchanging hazard situation.

Hurricane Charley left scenes of destruction along its path through Florida. This petrol station in Port Charlotte was a total loss.

Typhoon Tokage sped over Japan with wind speeds of up to 200 km/h. Buildings and infrastructure were severely damaged particularly in the region of Okinawa.

Watch out! Storms ahead!

Hurricanes in the Atlantic – Storms are brewing

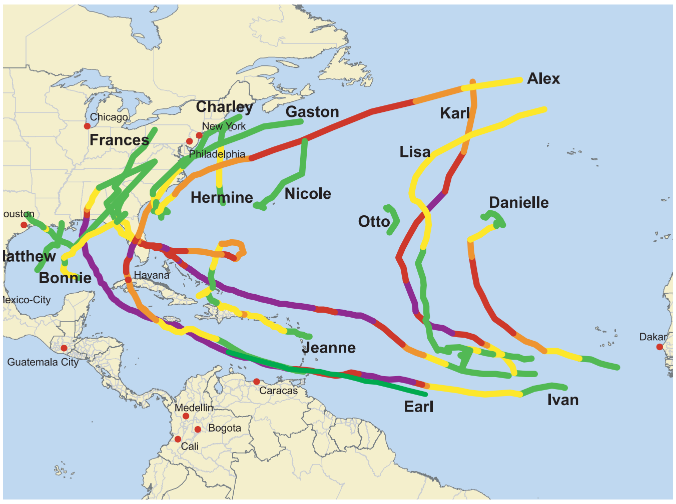
In 2004, there were 15 tropical cyclones in the Atlantic, nine of which reached hurricane force. Hurricanes Charley, Frances, Ivan, and Jeanne alone destroyed insured values of US$ 30bn – a record for the insurance industry.

Overall loss picture of the 2004 hurricane series in the Atlantic

The insured losses from the four most damaging hurricanes – Charley, Frances, Ivan, and Jeanne – with landfalls in the Caribbean and the United States came to a total of almost US$ 30bn (Table 1). The overall insured loss for the year as a whole thus represented a peak burden from tropical cyclones in the Atlantic for the insurance industry. The most expensive year for insurers in this region before then was 1992, when Hurricane Andrew generated insured losses of US$ 17bn. Munich Re estimates the event would cost almost US$ 30bn today on the basis of current values in Florida and Louisiana. The sum total of all the individual losses from the four major hurricanes in 2004 can therefore not really be called "exceptional".

However, many insurers responded to Hurricane Andrew by concentrating their efforts on estimating the accumulation loss potential of one event, without thinking so much about the possibility of higher loss accumulations from a series of medium-sized hurricanes. This is also reflected in the reinsurance constructions that were subsequently chosen, with private reinsurers probably carrying less than 25% of the overall loss.

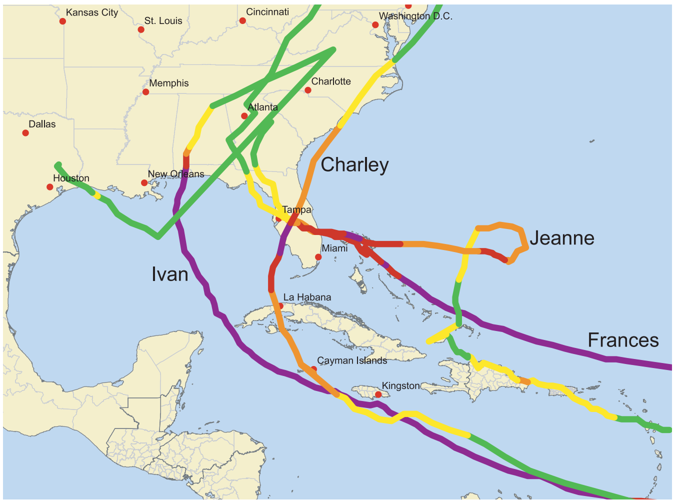
Fig. 1 Tracks of tropical cyclones and hurricanes in the Atlantic in 2004



In 2004, there were 15 tropical cyclones in the Atlantic, nine of which reached hurricane force with wind speeds exceeding 118 km/h.

< 100 km/h
100–150 km/h
150–200 km/h
200–250 km/h
> 250 km/h

Fig. 2 Four major hurricane loss events in Florida within a period of six weeks



The tracks of the four most destructive hurricanes in the United States during the 2004 season. The worst damage caused by all four tropical storms was in Florida. The track of Hurricane Ivan was remarkable in that it led to a double landfall in the Gulf of Mexico.

< 100 km/h
100–150 km/h
150–200 km/h
200–250 km/h
> 250 km/h

Meteorological features

The four costliest hurricanes – Charley, Frances, Ivan, and Jeanne – caused the worst damage in Florida. Between 1850 and 2004, there was only one similar accumulation of four hurricane hits in one US state, viz. in Texas in 1886. In Florida, the maximum number of loss events recorded in one year during this period was three – in 1886, 1896, and 1964.

Hurricane Ivan: A record length and intensity

Hurricane Ivan developed in the region of latitude 10°N and longitude 30°W on 2 September 2004 in the form of a rapidly intensifying tropical depression. Winds reached gale force on 3 September and hurricane force (wind speeds > 118 km/h) on 5 September. Within the next 18 hours, the storm system further strengthened from Category 1 to Category 4 on the 5-stage Saffir-Simpson Scale and reached speeds of 210 to 250 km/h. Ivan maintained this intensity for about 12 hours before weakening to Category 2. But that was only the run-up to a new record-breaking event. On 8 September, Ivan turned into a Category 4 hurricane again and did not fall below this level of intensity again until making landfall in Alabama on 16 September, in other words for about 200 hours. During that time, Ivan intensified to a Category 5 hurricane for several hours on three occasions. It reached its maximum wind speed on 12 September at 330 km/h (in gusts).

A measure of the peak duration and intensity is the Hurricane Destruction Potential Index, which is the sum of the squares of the maximum wind speed in 6-hour periods for the duration of the storm. Hurricane Ivan had an HDP index value of 71,250. By comparison, the long-term average of all tropical cyclones in an entire season in the Atlantic (1950–1990) was 70,600.

Record losses in the Caribbean

On account of the windstorm duration factor included in this parameter, a record HDP index value also means that there is a greater probability of land areas being affected. So it was not surprising that, on its way across the Caribbean – from Grenada to the Cayman Islands and on to Alabama and Florida – Hurricane Ivan generated an overall insured loss approaching US$ 12bn, thus becoming the second most expensive hurricane for the insurance industry after Andrew in 1992.

Grenada: On 7 September 2004, Ivan, now a Category 3 hurricane, hit the Caribbean island of Grenada, which was completely unprepared for such a storm. Such a high wind speed had not been observed in the region for at least 50 years. 39 people lost their lives and 90% of the buildings were damaged or destroyed. The economic loss on Grenada (population: 100,000) is estimated to be US$ 900m, but the insured loss is low on account of the small number of buildings insured. On the days that followed, the hurricane caused a further 15 fatalities on the islands of Trinidad, Barbados, and Hispaniola.

Jamaica: On 11 September, the eye of the hurricane was only a few tens of kilometres south of Jamaica. Almost all of the forecasts published at this time about the track said that Jamaica would be directly hit by a Category 4 hurricane within the next few hours. But Ivan changed course and only touched the southern and western parts of the island with its tail. The damage was relatively moderate: 17 people were killed, the economic loss was US$ 575m, US$ 100m of which was to be carried by the insurance industry.

Cayman Islands: The inhabitants of the Cayman Islands were less fortunate when the hurricane struck with all its fury the following day. As the first phase of the hurricane approached from the south, the wind on the main island of Grand Cayman was blowing from the east, forcing the water out of North Sound – a shallow lagoon in the northwest of the island – and onto Seven Mile Beach (Fig. 3). In some places, the storm surge reached a height of 1.5 m.

Hurricane destruction potential (HDP)

$$\mathrm{HDP} = \sum_{i=1}^{k} v_i^2$$

v = maximum gusts in knots within a six-hour period
k = number of six-hour periods during the lifetime of the hurricane

Wind speed v is usually given in knots in the United States. The sum of the squares of the maximum wind speed in each six-hour period provides an approximate measure of a hurricane's kinetic energy.

Whilst the centre of the hurricane passed only about 30 km southwest of the island, the wind veered to the south, so that the storm hit the southern part of Grand Cayman with its entire force and with a second storm surge.

The losses represented new highs in the recent history of the Cayman Islands. Insured property valued at almost US$ 1.5bn out of a total of US$ 5bn was destroyed. This corresponds to a claims rate (claims as a percentage of sums insured) of approx. 25–30%.

Offshore marine losses

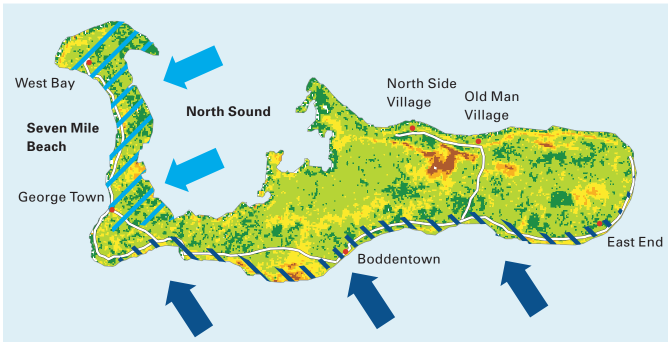
Even before making landfall in the border area between Alabama and Florida, Ivan had presented the insurance industry with a further negative record. On its northerly course in the Gulf of Mexico, it grazed the eastern edge of the offshore oilfields in the continental shelf off the US coast (Fig. 4).

With around US$ 2.5–3bn insured property and business interruption losses, Ivan is the largest ever loss in the offshore marine sector. For the sake of comparison, the total loss of the Piper Alpha oil rig in 1988 cost the insurance industry US$ 1.4bn, whereas the insured marine loss from Hurricane Andrew in 1992 was significantly below US$ 1bn.

The marine loss amount of US$ 2.5–3bn does not include the costs incurred for the precautions taken in response to the hurricane warning (evacuating rigs and throttling and stopping production).

This is a typical case of water damage. Two storm surges on Grand Cayman led to a large number of building losses.

Fig. 3 Grand Cayman



With 40,000 inhabitants, the Caymans are one of the more sparsely populated island groups in the Caribbean. Because of their great popularity as a tax haven, however, the insurance penetration is higher than the regional average.

City
Main road

Main loss areas
First storm surge
Second storm surge

Height above sea-level
< 4 m
4–8 m
8–12 m
12–16 m
> 16 m

Table 1 Overall loss picture of the 2004 hurricane series in the Atlantic

Date	Event	Affected area/islands	Economic losses*	Insured losses*
9–15.8.2004	Hurricane Charley	Jamaica; Cuba; Florida	18,000	8,000
25.8–9.9.2004	Hurricane Frances	Bahamas; Florida	12,000	6,000
2–24.9.2004	Hurricane Ivan	Grenada; Jamaica; Cayman Islands; SE United States	23,000	11,500
13–28.9.2004	Hurricane Jeanne	Puerto Rico; Dom. Republic; Haiti; Bahamas; Florida	9,000	5,000

* As at February 2005

If we look at the map showing the geographical distribution of offshore facilities in the Gulf of Mexico, we will see that the loss potential would have been much higher if Ivan's track had been further west.

Increase in the tropical cyclone hazard in the Atlantic

Neither the meteorological features mentioned above nor the record losses on the Cayman Islands and in the Gulf of Mexico may be seen as an indication of changes in the windstorm hazard in this region in recent years and decades. Nevertheless, they are good reasons for checking meteorological data carefully for possible trends or periodicities.

A closer examination of the annual numbers of tropical cyclones and hurricanes in the Atlantic reveals two different features in the time series for the period under observation:

1 Cyclical components: The frequency of windstorms increases or decreases in line with periodically recurring Atlantic warm and cold phases (cf. >> Climate change – Effects on tropical cyclones, page 41).
2 Upward trend: The number of tropical cyclones and hurricanes has generally increased over the last 150 years. The principal change has been in the frequency of major hurricanes, i.e. Categories 3–5 on the Saffir-Simpson Scale. The annual average has increased threefold (Fig. 5). Research is not yet clear on how much this upward trend is influenced by gaps in the data for the time prior to 1944.

Conclusion

The results of climate simulations indicate that the windstorm hazard in the Atlantic will continue to increase in the long term. More storms are likely to occur, so that cyclical maximum and minimum values corresponding to the Atlantic cold and warm phases will be higher.

Loss development underestimated in Florida?

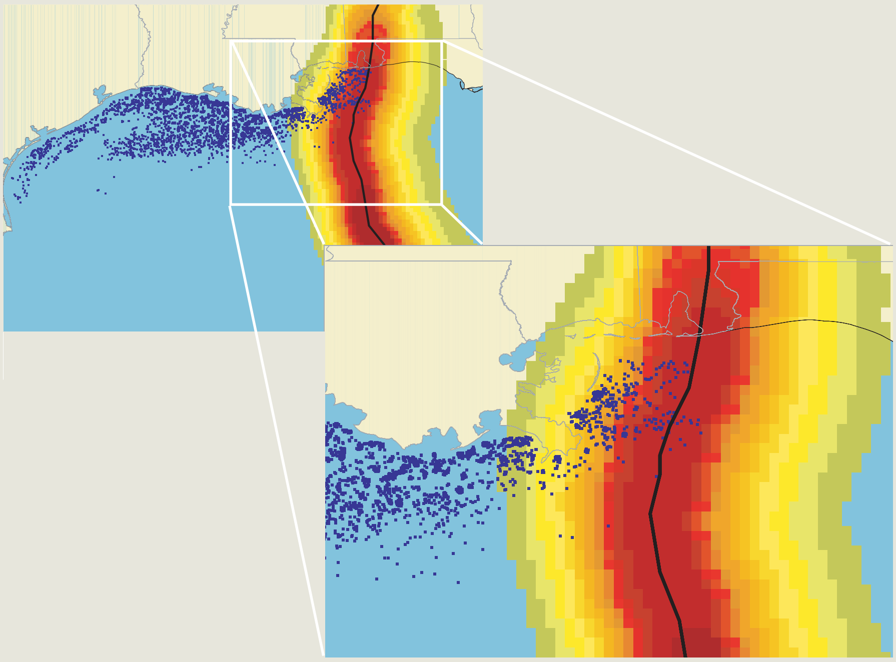
A change in the windstorm hazard potentially leads to a change in the windstorm risk. Even if we disregard for the moment years in which there are, by chance, particularly large or particularly small numbers of losses, the windstorm risk (loss expectancy value, accumulation loss potential) will change despite the fact that the circumstances of the insured risks (vulnerability) remain the same (Fig. 6).

It emerges that the loss expectancy value in Florida has increased almost constantly over the past 25 years despite the fact that the vulnerability of modern buildings to windstorm losses has decreased since the building code was upgraded following Hurricane Andrew.

The decisive factor for hurricane risk carriers is that the estimates of loss probabilities and loss expectancy values for Florida in the short to medium term (from the next few years to the next few decades) are too low – even assuming that the degree of hazard does not change (average of the past 150 years).

Fig. 7 shows that, based on an extrapolation of past losses to present-day values, insured losses from windstorm and flood in Florida increased during the period analysed. If the losses of the past 25 years indexed to 2004 values are aggregated over decreasing time window lengths, the increase in losses can be quantified by analysing the mean average insured loss per time window.

Fig. 4 Offshore installations in the Gulf of Mexico and simulation of the wind field

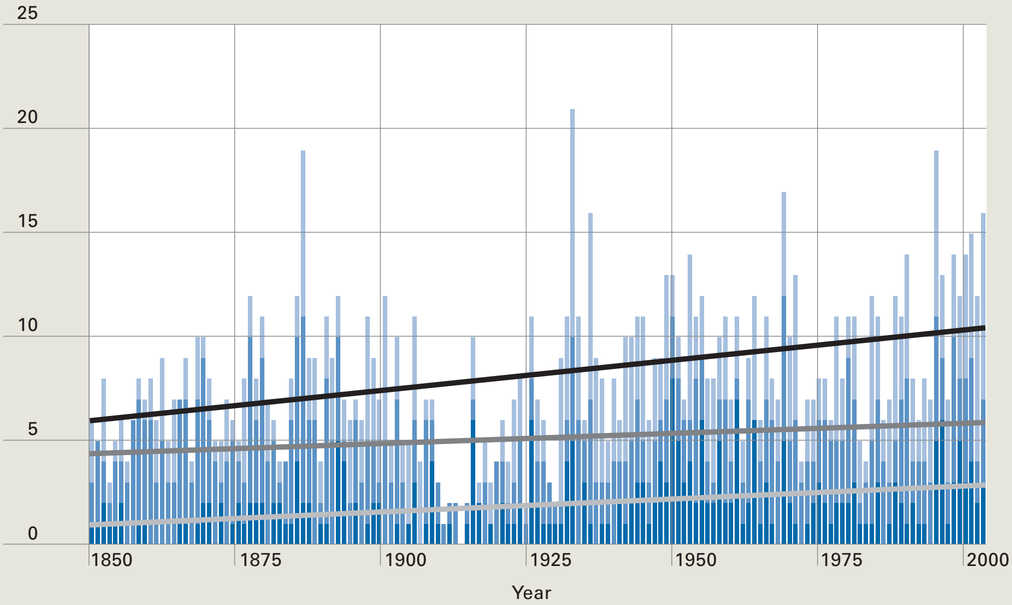


Platform
Track of Hurricane Ivan

Wind speeds in km/h
100–109
110–119
120–129
130–139
140–149
150–159
160–169
170–179
180–189
190–199
200–209
210–219
220–229
230–239
240–249
250–259
260–269
≥ 270

The track of Hurricane Ivan only grazed the eastern edge of the oil production area, but nevertheless caused the most expensive loss to date in this segment of business.
Source: US Department of the Interior – Minerals Management Service; Wind field simulation: Munich Re.

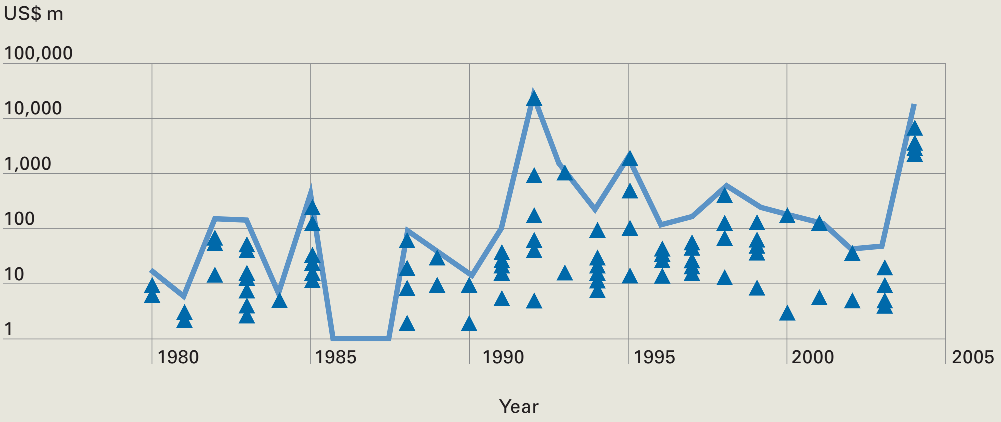
Fig. 5 Annual number of tropical storms and hurricanes in the Atlantic, 1850–2004



Hurricane and tropical storm
Hurricane (Categories 1–5)
Hurricane (Categories 3, 4, 5)
Trend: Hurricane and tropical storm
Trend: Hurricane (Categories 1–5)
Trend: Hurricane (Categories 3, 4, 5)

The frequency of tropical cyclones increased in the period 1850–2004. The most conspicuous change was in respect of strong hurricanes with an intensity of three to five on the Saffir-Simpson Scale with a threefold increase in the annual average. In 2004, the Atlantic saw six hurricanes of Category 3 or above. However, a general increase in the number of cyclones with landfalls in the United States has not been observed to date. There may be gaps in the data for the period prior to 1944 due to observations not being complete.
Source: NOAA

Fig. 6 Insured windstorm and flood losses in Florida, 1980–2004 (per event losses and annual aggregates)



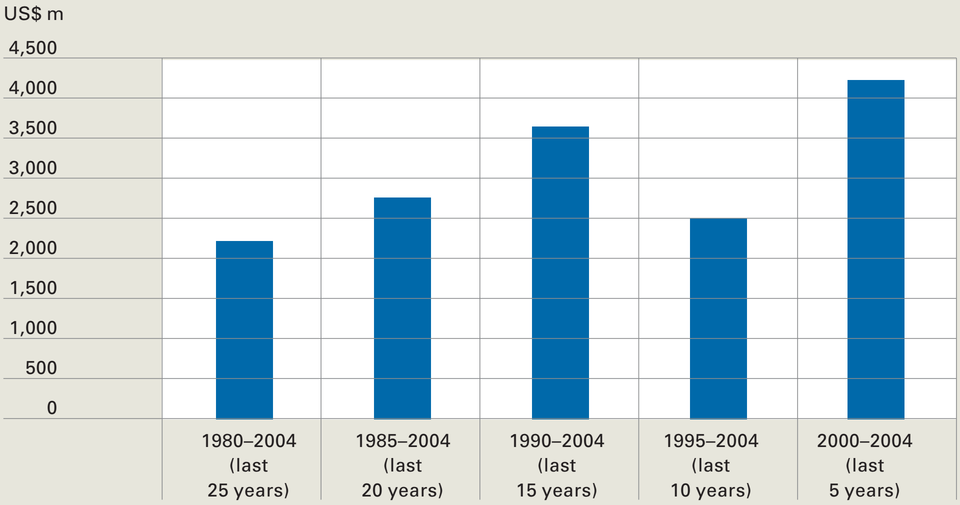
Source: Property Claims Service, Florida Office of Insurance Regulation, Munich Re NatCat*SERVICE*

Insured losses per event and annual aggregates from windstorm and flood in Florida in the period 1980–2004 (not including policies insured under the National Flood Insurance Program). Past losses have been indexed with an annual increase of 5% over 2004 values (taking inflation and portfolio growth into account). It should be noted that the loss amounts are plotted logarithmically.

▲ Per event losses 2004 values

▬ Annual aggregates 2004 values

Fig. 7 Average annual aggregate losses



Average annual insured losses from windstorm and flood (excluding NFIP) in Florida in different time windows. Past losses were indexed with an annual increase of 5% over 2004 values (taking inflation and portfolio growth into account).

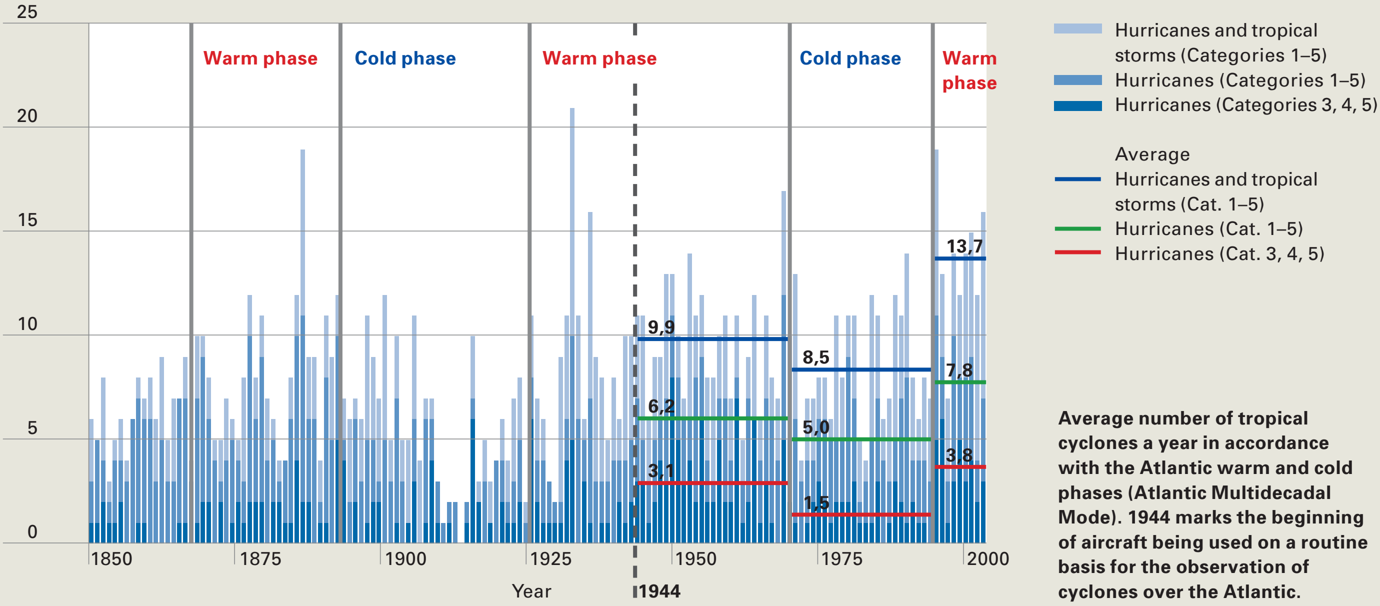
The loss potentials at trading estates are very high because warehouses and stores stand side by side in very confined spaces. This is a photo of a car parts store in Port Charlotte in Florida that was almost completely destroyed by Hurricane Charley.

Climate change –
Effects on tropical cyclones

If we look closely at how cyclone activity develops in the North Atlantic (along the east coast of America to the southern tip of Florida and in the Caribbean), one thing becomes clear: it certainly makes sense to equate Atlantic hurricane activity and periodically recurring Atlantic warm and cold phases – in line with the Atlantic Multidecadal Mode, which is currently a point of discussion in scientific circles (Fig. 8). These are phases with anomalously warm or cold water surface temperatures which usually last for several decades and occur particularly in the part of the Atlantic between 10°N and 20°N where cyclones mainly develop. If the water temperatures are unusually high, the evaporation increases and the atmospheric stratification over the water tends to become unstable. This increases the vertical strength of the developing cyclone and makes it less susceptible to vertical displacement. The latter may be the result of a change in the strength and direction of the wind between near-surface and upper levels. The vertical change in the wind is also reduced over warmer water surfaces. On average, there were 2.6 major hurricanes (Categories 3–5 on the Saffir-Simpson Scale) a year during the Atlantic warm phase, which began around 1926 and, apart from a very short interruption in the mid-1940s, lasted until roughly 1970. This is much higher than the average number in the Atlantic cold phase from 1971 to 1994 (1.5 a year). The Atlantic has now been going through a warm phase since 1995, which has distinctly increased the annual frequency of major hurricanes (an average of 3.8). The annual average number of major hurricanes is thus much higher in the current Atlantic warm phase than in the previous one. Does this mean that the cyclical structure of recurring warm and cold Atlantic phases is masked by an upward trend caused by global warming? This is exactly what recent studies using climate models would make one expect, viz. the development of tropical cyclones occurring in a warmer climate is more intense.

A new climate simulation performed for the three ocean basins of the North Atlantic, the Northwest Pacific, and the Northeast Pacific shows more intense cyclones in the second half of the 21st century (one-minute surface wind speeds will be on average 6% higher than in the present climate and precipitation levels within a 100-km radius of the centre will be 18% higher). Cyclones will be half a category higher on the Saffir-Simpson Scale than they are today. Although there is no proof that sea surface temperatures in the North Atlantic have risen appreciably in recent decades, many stations in the Tropics have observed a significant increase in the tendency towards convective processes in the atmosphere, which promote the development of cyclones.

Fig. 8 Annual number of tropical storms and hurricanes in the Atlantic



Average number of tropical cyclones a year in accordance with the Atlantic warm and cold phases (Atlantic Multidecadal Mode). 1944 marks the beginning of aircraft being used on a routine basis for the observation of cyclones over the Atlantic.

Source: NOAA, Landsea et al (1999)

Watch out! Storms ahead!

Further exceptional windstorm events

The year 2004 was marked not only by an increase in the windstorm exposure of areas that were already known to be at risk but also by individual exceptional meteorological events which provided further evidence of change processes in the atmosphere.

Hurricane Alex (Atlantic): Category 3 hurricane at 42°N

The 2004 hurricane season in the North Atlantic opened on 31 July with a tropical cyclone that had been considered almost impossible meteorologically. In the course of 1 August, a tropical depression off the coast of Georgia developed into a tropical storm which was given the name Alex. It gradually increased in intensity while moving northeast and on 3 August finally reached hurricane force (mean wind speeds greater than 118 km/h). That same day, its centre passed only a few kilometres away from Cape Hatteras in North Carolina. By then, Alex had already grown to a Category 2 hurricane on the Saffir Simpson Scale, with mean wind speeds of around 160 km/h, peak gusts of approx. 190 km/h, and a central pressure of 972 hPa.

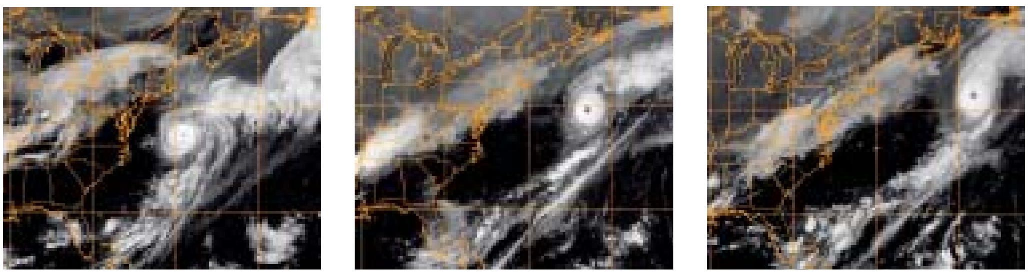
At this juncture, Alex was a perfectly normal hurricane, and as such a non-event from the insurance industry's point of view, given a track without any direct landfall on the US coast. Losses were restricted to the coastal strip between Wilmington (North Carolina) and Norfolk (Virginia), mainly involving power lines and local storm surge problems. The claims burden for these losses was below US$ 50m.

Alex initially retained its intensity in the course of 4 August, before weakening to a Category 1 hurricane, as expected, by the afternoon as it passed over the cooler waters of the North Atlantic at higher latitudes.

What happened next, however, was quite exceptional in meteorological terms. Within a few hours, the central pressure of the low-pressure vortex fell to 957 hPA and Alex transformed itself into a major Category 3 hurricane. On 5 August, reaching wind speeds of around 240 km/h in peak gusts, the hurricane moved further out into the North Atlantic in a north-easterly direction. Alex continued as a fully-fledged tropical cyclone with a Category 3 intensity and a central pressure of 957 hPa even over areas with water temperatures of under 26°C (a threshold that is one of the preconditions for the formation of tropical cyclones). The hurricane's forward speed of around 40–45 km/h was on the low side. It was not until the evening of 5 August that Alex started to weaken at a latitude of 42°N (approximately the latitude of Boston), being finally downgraded from hurricane to tropical storm on the afternoon of 6 August at a latitude of 47.5°N (approximately the latitude of St. Johns/Newfoundland).

The special features of Hurricane Alex may be summarised as follows:

- Acceleration of wind speeds and "reorganisation" of the low-pressure vortex north of Norfolk. It is remarkable that, at the beginning of August 2004, the Atlantic showed a distinctly positive temperature anomaly (3–4°C higher than the long-term mean) off the New England states of the United States and Canada.
- Retention of the features of a full-blown Category 3 hurricane with peak gusts of around 240 km/h in latitudes above 42°N.
- Weakening to an extratropical storm system only at a latitude of 47.5°N.



Left: Alex on 4 August 2004 at 3.45 p.m. (UTC) as a Category 1 hurricane off the coast of Virginia. Centre: Alex on 5 August at 6.15 a.m. (UTC) as a Category 3 hurricane at the latitude of New Jersey. Right: Alex on 5 August 2004 at 1.15 p.m. (UTC) at an unchanged Category 3 intensity. The storm did not begin to weaken until the evening hours (UTC).

Hurricane Catarina – or an "extratropical cyclone (depression) with tropical features" – in the South Atlantic

In March 2004 a storm system formed off the coast of Brazil (Catarina, also called Aldonca or 1-T Alpha in scientific literature) which in the course of its further development had many of the characteristics of a tropical cyclone. The South Atlantic has largely been considered hurricane-free up to now. This is due above all to the strong change in wind speeds between near-surface and high levels in the atmosphere which is extremely unfavourable for the birth of cyclones.

The meteorological analysis of this event was still in progress at the time of the editorial deadline (January 2005). On 26 March 2004, for example, the US National Hurricane Center in Miami (Florida) classed the cyclone as "tropical" and then as a Category 1 hurricane in its further stages of development. However, the Brazilian weather service classed Catarina as an "extratropical cyclone with a cold core", which is typical of cyclones that form over cold areas of water. The Centro de Hidrografia de Marinha used the term "extratropical cyclone with tropical features".

All the same, it is remarkable that according to one climate simulation experiment (Hadley Centre), Catarina occurred exactly in the zone between 20° and 30°S in which cyclone activity is expected in the future.

Regardless of the meteorological questions that still need to be answered, there is no doubt about the losses generated by Catarina: 40,000 damaged buildings (of a total of 125,000) in Catarina's landfall area and destruction in the agricultural sector to the tune of US$ 350m.

In March 2004, a storm system developed off the coast of Brazil that grew in intensity to a full-blown Category 1 hurricane on the Saffir-Simpson Scale. The photo shows the windstorm system at Porto Alegre in the southeast of Brazil.

The losses caused by Hurricane Catarina: 40,000 damaged buildings, agricultural losses, and damage to supply facilities. Four people were killed in the storm, 40 were injured.

Watch out! Storms ahead!

Loss report by Property Claim Services

The "Fab Four" hurricanes of 2004 – Professional loss adjustment in spite of dreadful conditions. A report by Property Claim Services ®

Tropical cyclones punished the southeastern United States in the 2004 hurricane season as severely as any cluster of catastrophes in recent memory. From early August to mid-October, six hurricanes – Alex, Charley, Frances, Gaston, Ivan, and Jeanne – plus three tropical storms struck the United States. The "Fab Four" – Charley, Frances, Ivan, and Jeanne – inflicted the most severe damage. Although none of these catastrophes had an individual impact of significant proportion on insurers or the properties insured, the overall impact of the four has been compared with Hurricane Andrew in 1992.

When Andrew made landfall in August 1992, the financial impact of what was then classified as a Category 4 hurricane was the worst the US insurance industry had suffered. That impact took on new meaning after the NOAA Hurricane Research Division in May 2004 upgraded Andrew to a Saffir-Simpson Hurricane Scale Category 5, a dozen years after the hurricane had struck Florida.

The four hurricanes last year caused insured losses currently estimated at US$ 22.5bn in 17 affected states, the largest hurricane loss during the same period since 1992. With the exception of 1992, the insured loss in 2004 is nearly seven times greater than the third costliest period – 1998. Combined third-quarter losses since 1992 have resulted from 22 hurricanes which were severe enough to be declared catastrophes by Property Claim Services (PCS) and caused US$ 50bn of insured property damage.

While similar in some respects, there is a striking difference between the effects of the "Fab Four" and Hurricane Andrew.

Although Andrew tracked across 15 counties in southern Florida, the most devastating impact occurred in Miami-Dade County and to a lesser degree in three nearby counties. Despite its relatively small dimension, Andrew, according to the PCS estimate, caused US$ 15bn of insured property damage to about 625,000 insured properties. That loss resulted in an average claim payment of nearly US$ 24,000, or about US$ 33,000 today.

In contrast, this year's four hurricanes affected nearly all 67 counties in Florida, 46 of which were declared federal disaster areas. Based on current PCS estimates for Florida alone, which are still subject to change, the four hurricanes caused US$ 18.6bn of insured property damage to 1.6 million insured properties, with an average-paid-claim estimate of US$ 11,500.

Following Hurricane Andrew, PCS analysed issues that ultimately influenced claims payments: shortages of labour, a spike in building supply costs, increasing demand for contractors' services, building permit, inspection, and application overloads on local authorities. These same problems exist today, though it is too early to tell how seriously they will affect the costs of rebuilding.

Poor building code compliance and enforcement was another significant issue after Andrew. It was estimated then that these related building code issues cost insurers US$ 4bn of the total US$ 15bn of insured damage. The first impression of many experts this year is that newer structures withstood the hurricanes much better than those structures built in compliance with earlier codes. This issue is still under investigation, but there is growing evidence in support of the effectiveness of the new codes.

PCS has for some time discussed the serious ramifications in the United States of a mega-catastrophe causing in excess of four million claims. Despite outsized losses from this past summer's four landfalling hurricanes, the insurance industry is still faced only with about half the number of claims in our worst-case scenario. The end results, however, reveal that the impact on insurers can result from either severity or frequency. This was not the first time that hurricanes made multiple landfalls in the US in the same season. There were four in 1964 and 1996, five in 1999, and six in 1985. The rarity is the consequence of the storms in Florida.

The process of handling the sheer volume of claims in Florida has been hampered by a number of very unusual factors.

About PCS

ISO's Property Claim Services® unit serves property/casualty insurers and reinsurers with estimates of anticipated insured losses on an industrywide basis arising from catastrophes, reflecting the total insurance payment for personal and commercial property items, business interruption, terrorism, workers compensation, and additional living expenses. The estimates exclude loss-adjustment expenses. PCS® defines all catastrophes – except those caused by terrorism – as events causing US$ 25m or more in insured property losses and affecting significant numbers of policyholders and insurers. The threshold for catastrophes potentially caused by terrorism is US$ 5m. ISO is a leading provider of products and services that help measure, manage and reduce risk. Property Claim Services is one of Munich Re's most important sources of information.

First, there were the evacuations of catastrophe adjusters as the hurricanes following Charley struck Florida. Never before in our memory have so many adjusters been forced to evacuate to safe locations – not once but twice. Coupled with widespread power outages and other utility failures, the first weeks of the adjustment process slowed considerably.

The hurricanes, especially Frances, caused the largest evacuations of Florida residents in history. Unfortunately, because of the serious extent of damage, particularly in the coastal regions, many of these residents were unable to return to their homes for extended periods of time, and insurance adjusters were unable to find living quarters in the areas where they were assigned to work. Adjusters' work was delayed further because they were forced to travel long distances between assignments and their living quarters.

Catastrophe adjusters had difficulty getting gasoline for their cars or had to wait hours in long lines to fill the tank in the car.

The process also slowed because adjusters needed to more carefully inspect damaged properties so that losses could be accurately allocated to a particular storm. Many areas in Florida suffered the brunt of Charley, Frances, and Jeanne. Damage caused by one was exacerbated by one or two more following it. Adjusters needed to analyse the overall impact so that they could correctly apply the appropriate deductible(s).

These problems reduced adjuster effectiveness measurably.

There was a positive aspect on the adjusting front. While the four major hurricanes affected 17 states and Puerto Rico, the majority of the damage occurred in Florida. As one catastrophe claims director noted, the concentration of damage in Florida allowed insurers to focus their resources there, thus making it easier to manage the response. Had the damage been worse in other areas, insurers would have been forced to establish operations in divergent locations, which would have increased the difficulty of effectively managing the overall response.

Insurers and their adjusting staffs have received kudos for the good work they have done in Florida despite the adverse conditions. Rebuilding in the aftermath of the worst hurricane season in a long time will take many more months. However, it is evident that insurers are striving to satisfy the expectations of their policyholders, regulators, employees, and stockholders, all of whom are interested in achieving the best outcome in a year of extraordinary happenings.

Gary Kerny

Watch out! Storms ahead!

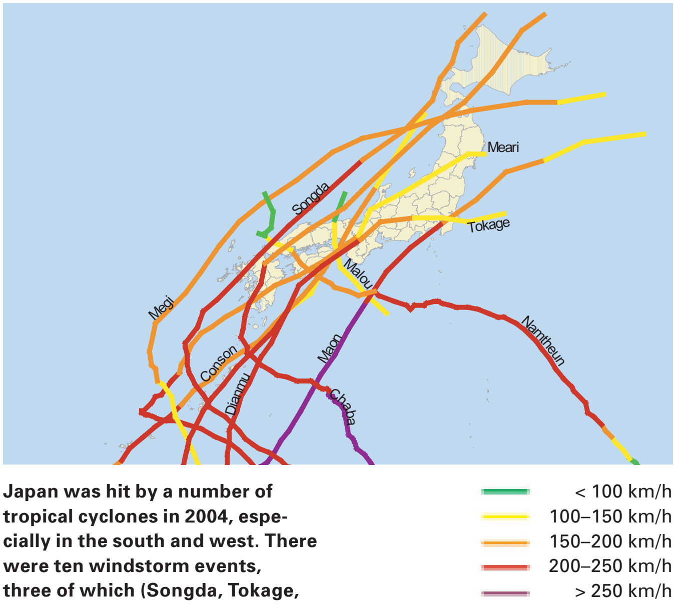
Typhoon season in the Pacific – Japan the target of cyclones

2004 was a year of windstorm records not only in the Atlantic but also in the West Pacific. The number of landfalls in Japan was the highest ever since the systematic recording of tropical cyclone track data first began.

The time window of just over 50 years is still too short for us to make a reliable statement on possible trends in the frequency of windstorm events in Japan. Nevertheless, it is noticeable that, in this region too, the most active windstorm periods during this time were in the more recent past (Fig. 2). The period with market data on insured losses from tropical cyclones is even shorter in Japan. As windstorm insurance was not introduced to mass business until the second half of the 1980s, only about 15 years' data is available for an actuarial analysis of the losses per event. Although there were significant insured losses in this period (Table 1), accumulation loss potentials can only be assessed reliably using suitable risk simulation models which include rare typhoon events with large losses (Figs. 3 and 4).

Whether it is necessary to consider a possible risk of change in the risk simulation for the Northwest Pacific is therefore more difficult to answer, since meteorological and underwriting data are less abundant and more subject to uncertainties than the Atlantic data. Applying the principle of caution in risk management, we have to expect windstorm activity to increase distinctly in the Northwest Pacific too in the medium to long term as climate change continues. Being larger than the Atlantic, the Pacific could by comparison slow down the trend on account of the thermal inertia of large masses of water.

Fig. 1 Tracks of tropical cyclones and typhoons in the Northwest Pacific with landfalls in Japan in 2004



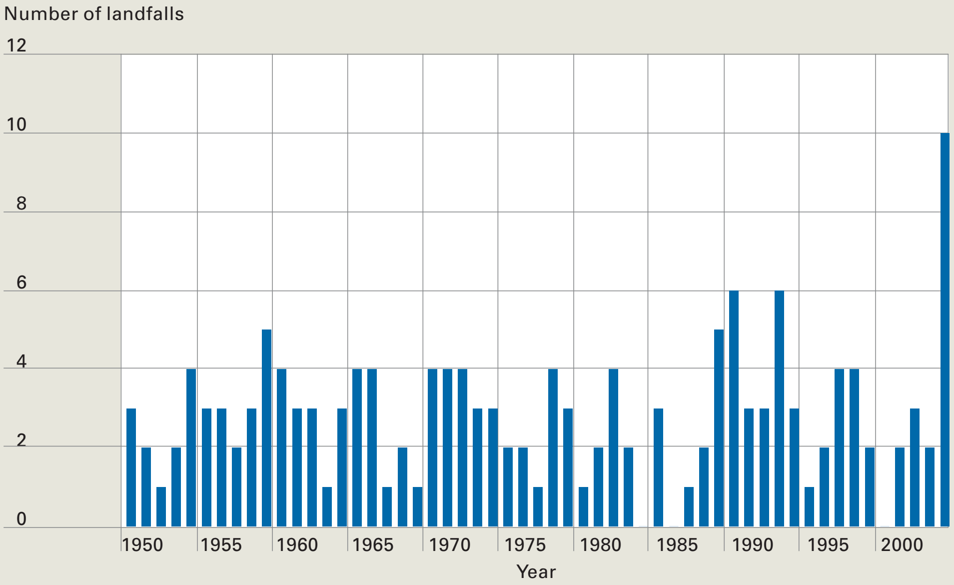
Japan was hit by a number of tropical cyclones in 2004, especially in the south and west. There were ten windstorm events, three of which (Songda, Tokage, and Chaba) were particularly destructive.

Table 1 The ten largest insured losses from typhoons in Japan, 1990–2004

	Typhoons	Date	Insured loss US$ m
1	Mireille (No. 19/1991)	26–28.9.1991	approx. 10,000*
2	Songda (No. 18/2004)	6–8.9.2004	4,700
3	Bart (No. 18/1999)	22–25.9.1999	3,900
4	Vicki (No. 7/1998)	22.9.1998	1,650
5	Tokage (No. 23/2004)	19–21.10.2004	1,250
6	Chaba (No. 16/2004)	30–31.8.2004	1,100
7	Yancy (No. 13/1993)	2–4.9.1993	1,000
8	Flo (No. 19/1990)	17–20.9.1993	490
9	Pat/Ruby (No. 12, 13/1985)	30.8–1.9.1990	480
10	Kinna (No. 17/1991)	14–15.9.1991	430

As-if losses in 2004.
*Due to a high degree of uncertainty regarding the development of values.
Conversion rate: ¥1,000 = US$ 10
Sources: NatCatService; General Insurance Association of Japan; as at December 2004

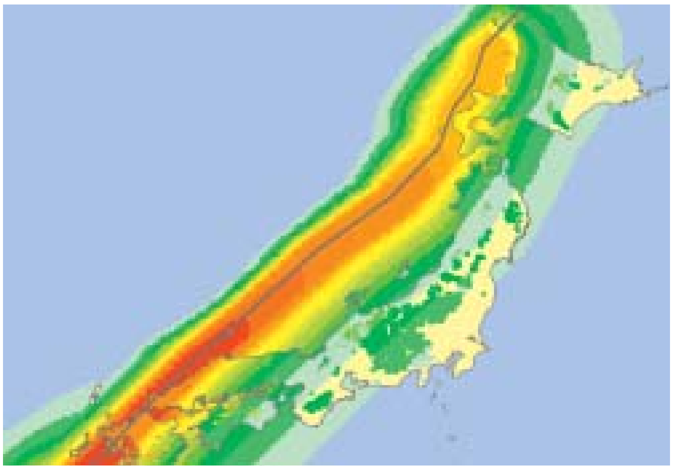
Fig. 2 Annual number of tropical cyclones and typhoons with landfalls in Japan, 1950–2004



Sources: Unisys, Japanese Meteorological Agency

In the period 1950–2003, the average annual number of tropical cyclones making landfall in Japan was 2.7. The largest annual number of landfalls was six, which was registered twice in the 1990s (1990 and 1993). 2004 was a record year with a total of ten tropical cyclones.

Fig. 3 Windfield simulation of Typhoon Songda, 2004



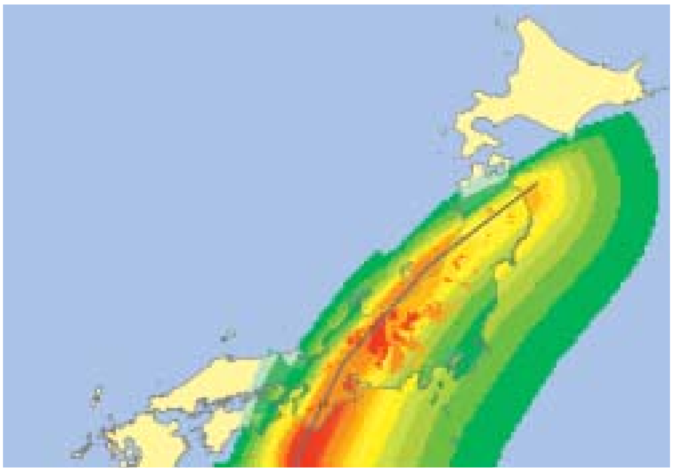
With insured losses of US$ 4.7bn (as at February 2005), Typhoon Songda (27 August–7 September 2004) was the most expensive typhoon in Japan in 2004.

Wind speed in km/h

60–69	190–199
70–79	200–209
80–89	210–219
90–99	220–229
100–109	230–239
110–119	240–249
120–129	250–259
130–139	260–269
140–149	270–279
150–159	280–289
160–169	290–299
170–189	≥300
180–189	

Track of Typhoon Songda (Fig. 3), Typhoon Vera/Isewan (Fig. 4)

Fig. 4 Windfield simulation of Typhoon Vera/Isewan, 1959



Typhoon Vera/Isewan (22–27 September 1959) On account of the higher wind speeds and concentrations of values in the landfall area, the simulated as-if losses from this event are a multiple of the insurance industry's bill from Songda. The loss figures from Vera/Isewan: 5,098 fatalities; 834,000 buildings with windstorm damage; 364,000 buildings inundated by the storm surge.

Windfield simulations: Munich Re

The insurance industry's adjustment strategies

In view of the loss potentials from windstorm and severe weather events, a possible risk of change must be taken into account at an early stage. A wait-and-see approach leads in the first instance to underwriting losses. However, a change in the distributions of large losses could be even more serious. This would increase the probability of insurers being ruined. What are the options open to the insurance industry?

– Short- and medium-term measures
These include an analysis of the loss accumulation from windstorms and severe weather events using simulation models which incorporate the risk of change and the provisions made to cover payment obligations.

The scope and price of the indemnities promised in the cover may need to be adjusted. In windstorm insurance, the introduction of deductibles is one way of reducing the accumulation loss potential. At the same time, steep premium increases can thus be kept to an acceptable level should they become necessary. Also, the reinsurance and retrocession tools that are used to optimise the balance of risks should be re-examined.

– Longer-term measures
These measures are intended to permanently reduce (insured) losses from windstorm and severe weather catastrophes (while still providing cover at reasonable conditions). Activities include the introduction or implementation of building codes to reduce the vulnerability to windstorm, improvements in the insurance industry's claims management, and in-house examinations of company practices and their impact on the climate.

Conclusion

2004 gave an impressive demonstration of the loss dimensions that may result from exceptional windstorm events. The increasing windstorm activity and the resulting risk of change must play a central role in the insurers' entrepreneurial decisions, above all in the underwriting process – regardless of the time horizon observed.

Dr. Eberhard Faust, Peter Miesen, Ernst Rauch

With wind speeds reaching 200 km/h, Typhoon Songda swept over Japan at the beginning of September 2004. Heavy rainfall and numerous landslides caused severe damage to buildings and infrastructure in large parts of the country. With insured losses of US$ 4.7bn, Songda is the second most expensive windstorm in Japan after Typhoon Mireille (1991).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Geocoded information facilitates more loss transparency

Efficient risk and loss management depend upon a high degree of transparency in the underwriting process. Geocoded information is particularly beneficial in this context. It can also be used to identify recurrent damage patterns and to resolve difficult insurance claims issues.

Many insurance experts are still somewhat in the dark as to what is meant by the terms geocoding and georeferencing. And this despite the fact that these terms refer to a method which has long been used by underwriters to identify and assess risks as the first step in making them insurable at all.

Topics – Annual Review: Natural Catastrophes 2002 presented an in-depth description of geoinformation technology and its potential uses in the underwriting process. Geographical underwriting is based on geocoded portfolio and loss data, which are provided by primary insurers and are of great significance particularly in connection with accumulation control (cf. TOPICS ***geo*** – Annual Review: Natural Catastrophes 2003). Geocoding involves the georeferencing of a risk, a process in which a policyholder's address or the location of a loss is expressed in terms of its geographical coordinates (longitude and latitude). This is performed at various levels of detail. The allocation of risks based on CRESTA zones (www.cresta.org) is a well-known system which is frequently used in property insurance. This system is often inadequate for meticulous loss management because small-scale or concentrated losses and damage patterns can only be identified at maximum resolution.

This information can also be processed statistically and combined with other data – such as weather records or historical losses – for complex risk analyses.

Visualising damage patterns

Geocoded risk addresses allow potential loss patterns and profiles to be derived for portfolios and specific natural hazards and can also be used for the computation of scenarios. They also provide assistance in resolving issues that may arise when a loss has occurred.

Damage patterns caused by windstorms

In order to determine a portfolio's windstorm vulnerability, the entire portfolio can be compared with the wind field information of a windstorm event. In the example shown in Fig. 1, all buildings that were exposed to wind speeds exceeding 80 km/h during Lothar in December 1999 (marked yellow) could be identified on the basis of the geographical connection between the wind field (shades of red) and a portfolio of residential buildings with several hundred thousand individual risks.

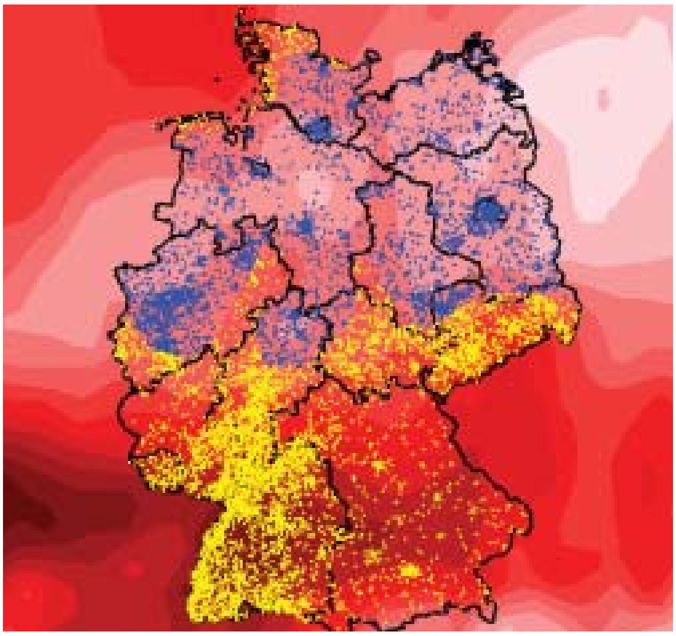
If the data on current severe weather events are reliable, correlations between these increasingly detailed data can even help to produce a quick, precise appraisal of the loss amount to be expected from a portfolio. In order to optimise the claims settlement process, focal areas with the largest losses can also be visualised.

Damage caused by lightning

The same goes for BLIDS, the lightning information service provided by Siemens. It supplies information quickly about where and when lightning strokes occur, how strong they are, and how thunderstorms develop (Fig. 2). To provide this service, BLIDS (www.blids.de) uses a network of weather stations in Germany, the Benelux countries, and Switzerland. Lightning strokes are localised to the nearest 300 m. Georeferenced information can thus be used as a basis for taking prevention measures aimed at loss minimisation. Public utilities need information on approaching thunderstorms for the operation of their networks and for the deployment of adequate manpower. The causes of breakdowns and destruction can be investigated in depth after a lightning stroke. This is important for the insurance industry too.

Criminals are geocoded too

Current GIS developments, particularly in the United States, are focusing on new crime mapping and crime analysis applications which use geocoding as a basis for the analysis of criminal activities. Data on the culprits, the locations of crimes, and the types of offence involved (e.g. burglaries, car thefts) are used to detect spatial relationships between the locations of crimes and the addresses of suspects or to identify the procedures adopted by organised criminal groups. Series of crimes are brought to light and permit hot spot analyses that can be used for preventive strategies and police deployment planning (Fig. 3).



Winter Storm Lothar (km/h)

20
30
40
50
60
70
80
90
100
110
120
130
140
150

Residential buildings exposed to windspeeds of less than 80 km/h

Residential buildings exposed to windspeeds exceeding 80 km/h

Fig. 1: The combination of wind field data and policy information with exact addresses makes it possible to identify damage patterns and to quickly assess expected losses.

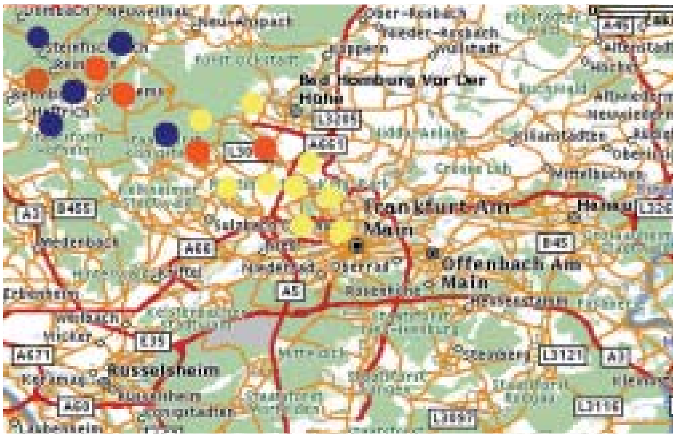


Fig. 2: Detail from a BLIDS product, showing the track of a thunderstorm and the distribution of lightning strikes. The bullets show the various lightning strengths. This kind of information can be used for the purposes of early warning and claims investigation (www.blids.de).

Fig. 3: Burglaries in Munich; detail from GLADIS, the crime-mapping tool that has been used by the Bavarian police in Munich since 1999.

Fig. 4: A typical palm device with an integrated GPS receiver. Cartographic data and clients' addresses can be called up on the spot following major catastrophes.

Hot-spot analyses integrate data on crime-relevant or security-relevant buildings like banks, jewelleries, or consulates and widen the scope of these tools substantially. The same goes for socio-demographic and socio-economic data, which provide information on residents, structures, and codes of behaviour.

In Germany, these methods were first incorporated in geoinformation and manpower planning systems at the end of the 1990s. They are used by the police in Lower Saxony, Stuttgart, and Bavaria (Fig. 3). The insurance industry will probably benefit from their findings and experience in the future.

Loss identification and fraud prevention from outer space

With more and more satellites sending more and more detailed images back to the earth, support is increasingly coming directly from the sky – as in the case of an insurer who was notified of a loss that had occurred at Munich Airport. A mixture of snow and grit that had been churned up in a storm was alleged to have damaged several aircraft. Satellite images taken at the time of the loss occurrence proved that this was not the cause. There was no snow-dumping area in the immediate vicinity of the aircraft.

There are two main problems with gathering evidence from outer space: firstly, the cloud cover makes many systems "blind" and, secondly, the orbit times of many satellites do not allow permanent observations.

Geocoding, combined with specially processed up-to-the-day satellite images, is also used for control purposes in the agricultural sector. Beginning in 2007, the firm Rapid-Eye (www.rapideye.de) is planning to offer satellite-based services and analyses to agricultural insurers. The aim of these services is to make it easier to forecast crop yields and to enhance the accuracy and speed with which crop losses can be estimated after hailstorms, windstorms, droughts, and frost.

Future support from outer space

Marine insurers, especially those that are particularly exposed to insurance fraud, can hope for support from the georeferencing processes of GPS technology (global positioning systems) and the future European Galileo system. By means of "vessel tracking", the locations of mobile risks like fleets of vessels and vehicles can be followed precisely together with their valuable cargoes.

Combined GPS and geodata applications will also be used in the future for the purposes of claims handling, particularly after major natural catastrophes (e.g. cyclones and earthquakes). Even today, for example, it would be technically possible to equip loss assessors with palms or PDAs (Personal Digital Assistants) incorporating not only the most important geocoded client data but also a small GPS device to display the exact location (Fig. 4).

Such a constellation would not only make it easier to find the addresses of clients or the location of losses but could also prevent fraud by ensuring that the assessor would inspect the policeholder's building rather than the most severely damaged building in the road. This example is often quoted for disaster areas where no other orientation is possible.

Conclusion: In purely technical terms, all these tools are already available today. It is up to us, the insurers, to take advantage of the possibilities that offer the greatest loss minimisation potential.

Andreas Siebert

Climate summit in Buenos Aires – Breakthrough for climate protection?

The 10th session of the Conference of the Parties (COP10) was held in Buenos Aires in December 2004. In spite of the initial optimism, the negotiations on the Kyoto Protocol made slow progress – although scientific evidence is mounting that climate change is real.

There is no longer any doubt that more weather extremes must be expected in a warmer climate. To this extent, the intense cloudbursts that were unleashed over Chacao, a state in northeast Argentina, on the very first day of the 10th climate summit (5–17 December) seemed to be a good piece of stage management. Some places recorded 800 mm of rain in three days, which is almost equivalent to the amount statistically expected in a whole year. An area measuring 6,000 km^2, including valuable arable land, was affected. At the same time in Buenos Aires, some 5,000 participants from 189 countries were discussing how to reach a global assent on curbing climate change. The central issue was: What is to be done next in the Kyoto process?

It started out as an optimistic climate summit. After all, Russia had ratified the Kyoto Protocol in November, meaning that it could finally come into force on 16 February 2005. But in the course of the first day of negotiations, the delegates' optimism and enthusiasm gave way to a crippling political tug-of-war between the European Union, the developing countries led by China and India, and the customarily difficult negotiating parties, the United States and Saudi Arabia.

The chief issues were whether constructive negotiations on the second commitment period after 2012 could begin in 2005 and how the Kyoto Protocol could be implemented. While the EU wanted to address the issue of future climate policy, China and India refused to even discuss obligations with regard to reducing greenhouse gas emissions after 2012. The emerging countries argued that the limits on carbon dioxide emissions could slow down their economic growth.

Nevertheless, India and China came out in favour of renewable energies – which was one of the most important upshots of the climate summit. The US delegation were less cooperative and hampered the talks. Although the USA have not ratified the Kyoto Protocol, they are to stay on board. Therefore, hope remains that the United States will one day participate in the Kyoto process, perhaps if US business recognises the potential of new Kyoto markets and consequently exercises pressure on the country's

On the occasion of the climate summit, the UNEP Finance Initiative (UNEP FI) issued its fourth CEO Briefing, this time on the subject of CDM. It states that banks and insurers need a long-term binding framework if they are to provide their full support for the financing of solutions.

Political processes are taking effect – European emissions trading launched on 1 January 2005

Industrial enterprises in certain types of business are only permitted to release the amount of carbon dioxide into the atmosphere to which their emission allowances entitle them. If they do not have enough allowances, they must buy more; if they have a surplus, they can sell them. Emissions trading thus translates the emission of one of the key climate-changing greenhouse gases into operating costs. In the Kyoto Protocol, the EU set itself the target of an 8% reduction in its greenhouse gas emissions by 2012 (compared with 1990). Germany will reduce its emissions by 21%.

The German targets for the sectors involved in emissions trading were fixed at 503 Mt by 2007 and 495 Mt by 2012 (current annual emission: approx. 505 Mt). A total of 1,849 facilities are participating in the emissions trading scheme. More than two-thirds of them (1,236) are in the energy sector, whilst 613 are in other emission-intensive industries (e.g. ceramics, paper, glass, lime, cement, iron and steel).

EU-wide, 21 of the 25 member states started trading as soon as the scheme was launched. The EU Trading Directive has been supplemented so that emission allowances issued for recognised climate protection projects in developing and emerging countries (e.g. Brazil, India, China) may also be included in the scheme. Climate protection is thus achieved where the costs are lowest.

political leaders. After all, the Kyoto Protocol will create opportunities for new products, services, and – last but not least – jobs in rapidly expanding markets with future potential.

Financial services providers call for binding statements on the time after 2012

Even if the results of the official negotiations were rather meagre on the whole, there was quite a lot happening behind the scenes. Financial services providers (banks and insurers) partaking in the UNEP Finance Initiative took the stage at side events and presented the financial sector's view. The message to politicians was clear: standards should not be established without due consideration being given to the complex processes involved in implementation. Financial services providers play an important role, especially in connection with the Kyoto mechanisms, i.e. the instruments designed for the implementation of the Kyoto Protocol (emissions trading, joint implementation, and the clean development mechanism).

The best example of this is the clean development mechanism (CDM), which was created in Kyoto in 1997. This mechanism relates to environmental cooperation between industrial and developing countries. If a project manager installs a low-emission wind turbine in a developing country, for example, many services need to be provided by banks and insurers: start-up financing, marine insurance, contractors' all risks (CAR) and erection all risks (EAR) insurance, credit and liability insurance, and the new insurance product designed to cover the risk involved in trading emission allowances. Politics can only have a sustainable effect if the financial sector's role is recognised and acknowledged: if banks are not involved, plants and facilities will be built at a very slow pace or not at all; if insurers are not involved, claims expenditure may accumulate so rapidly, e.g. in the case of wind power plants, that the cost effectiveness of the project is threatened. At side events and press meetings, the members of the UNEP FI Climate Change Working Group described the political framework that is needed if financial services providers are to be able and willing to implement CDM projects in the first place. The technical hurdles were at the centre of discussions with representatives from all over the world, and it is to be hoped that the voice of the financial industry has found an adequately receptive audience.

United Nations Framework Convention on Climate Change – What comes next?

It was not until the end of a 24-hour session on the very last day of the conference in Buenos Aires that delegates finally came to an agreement on the Buenos Aires Action Plan. Demonstrable progress is required from the negotiations in Bonn in May 2005. It is quite feasible that important agreements will be concluded that will greatly influence the future of the climate after 2012.

And another thing is important even if hardly anyone talks about it now: at the climate summit in Buenos Aires, the remaining formalities were completed that will allow the Kyoto Protocol to come into force on 16 February 2005. The Kyoto Protocol is only a first small step, but as the old Chinese proverb says, every journey begins with a single step.

New scientific findings on climate change

The latest research findings and measured data underline the urgent need for action at all levels if we are to meet the challenge of climate change.

– 2004 is high up on the list of the warmest years. According to World Meteorological Organisation records, it was 0.44°C above the average of the climate normal period (1961–1990: 14°C). It was also the fourth-warmest year since 1861, with a global mean temperature that had only been exceeded in 1998, 2002, and 2003. Whilst the 1990s were the warmest decade on record in the northern hemisphere with a mean deviation of +0.38°C from the climate normal period, the mean deviation of the last five years is already much higher at +0.58°C. The earth is warming up at an increasingly rapid pace.

– On account of the number and intensity of hurricanes in the 2004 season, scientists have been looking into the correlations between climate change and the birth of hurricanes (see the article on page 41). On the basis of the latest US climate simulations by T. R. Knutson and R. E. Tuleya (Journal of Climate 2004) more intense cyclones must be expected for the second half of the 21st century (with, on average, 6% higher one-minute surface wind speeds and 18% higher precipitation levels within a 100-km radius of the centre). Cyclones will be half a category higher on the Saffir-Simpson Scale than they are today. In recent decades, many stations in the Tropics have observed a significant increase in the tendency towards convective processes in the atmosphere, which promote the development of cyclones.

– Finally, new analyses have also been published (NATURE Vol. 432, 2004) on Europe's hot summer of 2003 (cf. TOPICS ***geo*** 2003) and focus in particular on the question of the contribution made by human activity. Their findings show that more than half – and possibly even three-quarters – of the risk of such a hot summer can be attributed to human impact. The probability that this analysis is wrong is only 10% or even lower. In the course of the next four decades, the probability of an extreme summer like 2003 could increase by a factor of one hundred as a result of continued global warming. This investigation is of central significance as the trend in climate attributable to human activity can be quantified. Conclusion: the probability that such events will occur has distinctly increased as a result of climate change.

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